NOTES ON THE MANUFACTURE

OF

WOOD PULP AND WOOD-PULP PAPERS.

NOTES ON THE MANUFACTURE

OF

WOOD PULP

AND

WOOD-PULP PAPERS.

By JAMES DUNBAR,

Author of "The Practical Papermaker."

Price, 2s.; by Post, 2s. 3d.

PRINTED FOR THE AUTHOR BY
MACKENZIE & STORRIE, 35 SHORE, LEITH.

MDCCCXCIV.

PREFACE.

IN my previous efforts to put before the paper trade a reliable Guide to the Manufacture of Paper, based upon my own practical experience, I confined myself to the raw material best known to me at that time. But since the issue of the last edition of my book a decade in papermaking seems to have passed over us; and, with the advent of a popular and comparatively new material, which is better known on the Continent of Europe than with us, and which is fast coming to the front, I consider the present a fit opportunity to put my experience of wood fibre manipulation on the Continent before the trade. The result I leave to practical men. If I am enabled to add a little to the knowledge of those engaged in the papermaking industry (especially the rising and younger portion), it will be a pleasure to me to know that I have thus been of some help to them.

I have endeavoured to confine myself to what I consider up-to-date information relating to Wood Pulp and Wood-Pulp Papers, and the application of the latest ideas to machinery used in their manufacture, with suggested improvements which have for their object the saving of time and consequent cheapening of production. In this I am much indebted to Bertrams Limited, St Katherine's Works, Sciennes, Edinburgh, who have kindly supplied the illustrations, which will, I am confident, be found useful for reference, and an aid to what is meant by the various suggestions as to improvements.

I assure my readers that the details here given have all come under my own immediate observation—nothing having been added to nor taken from them. In short, they are precisely what I have seen put into practice day after day, with the most satisfactory results as to economy and efficiency.

JAMES DUNBAR.

Note.—The matter contained in this book is entirely distinct from that appearing in "The Practical Papermaker," which may still be had from Mackenzie & Storrie, 35 Shore, Leith.

INDEX.

PAGE

Sulphite Pulp . . . 1

Sulphate of Soda Cellulose . . . 7
  Hand-Barking . . . 9
  Boiling Department . . . 11
  Draining Tanks . . . 12
  Washing Department . . . 13
  Straining Department . . . 13
  Bleaching Department . . . 14
  Cellulose Drying Machine . . . 15
  Sorting Department . . . 16
  Packing Department . . . 16
  Soda Recovery Department . . . 16
  Sulphate of Soda Pulp: its Manufacture into Paper . . . 17
  Treatment in the Beater . . . 18

Esparto Papers . . . 26
  Spanish Esparto . . . 27
  African Esparto . . . 27
  Tripoli Esparto . . . 27
  Cleansing Esparto . . . 28
  Esparto Boiling . . . 28
  Washing and Bleaching . . . 29
  Half-Stuff Machine . . . 30

Mechanical Department . . . 35
  Conical Engines . . . 35
  Paper Machine . . . 37
  Water-Power . . . 40

Chemical Department . . . 42
  Tub-Sizing . . . 42
  Bleach Test . . . 43
  Phlorogusine . . . 43
  China-Clay . . . 44

PAGE
Possible Improvements 48
    Couch-Roll Brackets 50
    "Doctors" on Cylinders and Calenders . . . 50
Remarks 55
High-Class Duplex Paper 63
Finishing Paper 65
    Web Calendering Department 66
    Friction Calenders 70
Pearson and Bertram's Refining Engine 73
Paper-Machine Wire 75
Conclusion 82

Wood Pulp and Wood-Pulp Papers.

SULPHITE PULP.

SULPHITE PULP is one of the strongest of the wood-pulp family; it is also one of the best brands, and ought to be ranked as a perfect fibre. The process of manufacture being protected by patents, I have no right to enter into details on that subject, but will confine myself to a description of the manufactured article.

The best brands are clean, of a slightly rose tint, of a fine silky fibre, and pleasant to the feel and the eyes. One will say, What has the feel of a fibre to do with its value as a papermaking material? I must say it has much to do with it, as a hard harsh material will not make a kindly-feeling paper, which is so much desired by the printer, but will produce a paper which does not take kindly to the type, the result being an imperfectly printed sheet,—which is a source of much annoyance to the workman, and the cause of blame being thrown upon the shoulders of the person who is neither responsible for nor able to bear it. This pulp, if properly treated, may enter into the composition of a comparatively fine paper, with the best results. But the extraordinary care which must be exercised in its preparation, to prevent its tendency to flake or cloud, has been the means of giving it a bad reputation as a material for the production of fine papers. This tendency can be avoided if the material gets full justice. It can be, and is, successfully manufactured into cartridges, manillas, engine- and tub-sized writings, and fine printings, if used either alone or with rags, both of which systems are practised on the Continent.

In the production of news and other common papers with Sulphite and Mechanical Pulp the result is most satisfactory. This, of course, means the use of the common brands of Sulphite Pulp. Although not perfect in cleanness, it is strong, and well fitted, as far as strength and cleanness are concerned, to compete most favourably with the common fibres used for the same purpose, economically and otherwise. To compare Sulphite Pulp with rags, as an economical fibre and a fibre which will produce an equal paper when the cost of production is taken into consideration, is entering upon debatable ground, as every papermaker's facilities are not alike for economical production; and it is a well-known fact that the same paper is not produced in different mills from exactly the same material, the reason being best known to the papermakers themselves, and possibly in a great measure attributable to the local surroundings and the available facilities for producing an up-to-date and first-class article. But I must say that the very best brands of bleached Sulphite Pulp, in my opinion, are more valuable and cheaper as a papermaking material than many of the grades of rags used for papers for which Sulphite is best adapted. Sulphite Pulp is cleaner, stronger, and keeps the mill clean, which is a very important consideration indeed. There is no dirt or dust blowing about the mill, no boiling, no washing and bleaching—that is, if the pulp is purchased in a bleached condition. In fact, there is a total absence of all the dirty processes which have been the bone of contention between the paper manufacturer and either the landed proprietor or the sanitary authorities—and which have cost the former so much money, and given him so much trouble—as to the pollution of streams which never were clean.

To treat Sulphite Pulp as is done on the Continent of Europe for a fine printing or engine-sized writing paper, the beater roll should never be put down heavily upon it. The fibre is an exceedingly fine one, although of great length, and is best treated with the drawing-out process, which has the tendency not only of clearing out but of finely separating the fibres, both in length and in diameter, to the desired uniformity for the various papers for which this pulp is suited. And, by giving the stuff a firm hard brush at the end of the beating, a finished pulp will be produced, capable of making a close and uniform sheet of paper, which will not flake or cloud, or take the appearance of a wood paper, but will feel and look more like a hard rag paper, made from a much more expensive material than Sulphite Pulp.

I will now try to describe the action of Sulphite Pulp on the paper machine. We will conclude that the beaterman has done the best he can in his department, which, I must say, is the vital part of papermaking. If the stuff has been prepared for a fine printing paper, the shake motion must not have a high speed, but a reasonably long throw. This treatment will avoid the flaking, and a close uniform sheet will result. On the other hand, if an antique or cartridge paper is desired (which means in most cases a hard rattling paper, to take the character of a hand-made paper), it must be shaken on the machine at a high speed with a comparatively short throw. Under no circumstances should an exceedingly long shake be given to wood papers, as it is this, and this alone, which facilitates the flaking, and makes the paper look like a rope-brown—wild, cloudy, and marley. A few experiments with the shake motion are of more value than any written instructions, especially when applied to the manufacture of fine printings—this not applying so much to antiques and cartridges.

A most important item in the management of wood papers on the machine is the drying of them. This amounts to a fine-art in the manufacture of wood papers, and it takes a highly proficient machineman to carry the process through in a thoroughly satisfactory manner.

Paper machines have been built in this country and in Germany specially for the manufacture of wood papers, with the most satisfactory results—particularly so with our own make of machine, which I will describe at some length, showing where we produce a perfect machine, and where the German errs.

It is well known to papermakers that wood papers are most difficult to dry, under ordinary conditions; but with a properly-constructed machine the result is most satisfactory. One of the largest engineering houses in Scotland has built a machine which meets all the requirements of the paper manufacturer in this respect, by the introduction of the three-sets-of-press-roll system. The origin of this system is undoubtedly German; but the German counteracted the benefit of three presses by reducing the number of drying cylinders. Hence the desired effect was not obtained by him. Our engineers at once grasped the situation, and introduced a machine which fulfilled all their expectations by producing the desired paper. This three-sets-of-press-roll system, not yet being adopted to any great extent, requires from me some explanation, which I will try to give in as intelligible a manner as possible.

The first idea of introducing three sets of press-rolls was economy of fuel; but, at the same time, it accomplished another and very important change in the working of the paper machine. The German, as he added presses, reduced the number of cylinders, consequently destroying the first effect; whereas our engineers have been rather inclined to add to the number of drying cylinders along with the additional sets of press-rolls. And rightly too in practice, for the reason that, by the use of three sets of press-rolls, the paper is made comparatively dry while not yet having been subjected to artificial heat. As a natural consequence (a lower temperature being required on the cylinders), the paper passes on to the reel without being subjected to that roasting process which is common on many of our ordinary machines. But the German, by reducing the number of the drying cylinders, had still to keep up a high temperature, which roasted the paper, and, in the case of wood papers, produced them brittle and unsatisfactory. Of course, paper manufacturers naturally ask, What about the bulk of the paper under the pressure of three sets of press-rolls? I maintain that the bulk is not injured in the slightest degree. The idea (held by myself as well as others) that hard pressing injured the bulk of the paper, is now exploded. Paper pressed between felts will not get thinner. I have had it tested upon many differently-composed papers, with the result that there was no material difference. The smoothers and the calenders do thin the paper in a small degree. But I do not call even that a thinning process; it is rather a very necessary levelling and smoothing operation. When the stationer cries out about bulk, believe me, it is not the press-rolls which are at fault; and if he wants an 18 lb. demy to feel like a 20 lb. demy, the best way is to tell him that it cannot be done.

The excessive use of china-clay will, to a certain extent, injure the bulk of the paper and make it feel thin for its demy weight. But such paper would feel thin if you should pass the press-rolls altogether; and I am pleased to say that such paper is never put on the market by the British paper manufacturer.

I strongly advocate the three-sets-of-press-roll system, and consider it one of the best additions to the paper machine for the rational manufacture of paper from any fibre, but especially wood fibre. I have met men in my wanderings who, if they could, would dispense with press-rolls altogether, with a view to save felts—a very laudable object certainly, if it could be accomplished. As I understand the manufacture of paper, press-rolls do more than lead the paper and press out a certain amount of water from it. They solidify it, level and smooth it, and render it fit to be handled in leading it through the cylinders. The advocates of dispensing with the press-rolls overlook or forget these facts, while every intelligent papermaker will, I am sure, agree that I am right in this matter.

I will now try to describe the manufacture of Sulphate of Soda Cellulose; and, as there is no fear of meddling with other people's private affairs, I will begin at the foundation, and finish with the manufactured paper.

SULPHATE OF SODA CELLULOSE.

The wood is conveyed to the mill by sea and rail. It is a mistake to imagine that wood-pulp mills are planted down in the midst of an inexhaustible forest, where the wood supply is ample for all time coming. This is not the case. The pulp manufacturer must go many miles for his supply of raw material, and this at considerable cost.

Swedish wood for consignment to Norway is, as a rule, carried by rail, and most of the Norwegian wood by sea, or by small craft which ply on the fjords. When the wood arrives at the mill, each lot is piled up in the mill-yard separately, and allowed to remain there until it is examined and the management satisfied that the various consignments are according to contract, and fit to be manufactured into the best brands of pulp.

They are then passed over to the bark-removing department, which is the first cleansing process to which they are subjected. This bark-removing process was, in the early history of pulp manufacture, done by hand; but of late years several sorts of machines have been introduced for the purpose, but with indifferent success where economy of wood was a consideration. The machine for bark-removing which is considered the best will remove the bark quickly and economically if the wood is perfectly straight and round; but if it is otherwise, there is so much of the good wood removed before all the bark is off, that it comes to be a very expensive operation. Consequently, many of the mills which had adopted these machines have abandoned them and gone back to the old system of hand-barking, which is cheaper and more economically done, especially when you take into consideration the probable percentage of crooked and uneven wood to be found n a consignment of, say, five or six cubic fathoms given out to each man, from a consignment of 800 to 1000 cubic fathoms received at the mill. However, a description of the barking machine will not be out of place, as it might be a very valuable machine to have where there is a possibility of trouble with the workmen, which is not at all a rare occurrence in nearly every trade.

The machine consists of a strong cast-iron V-shaped trunk, cast in one piece. Across the top is a malleable-ron shaft, 4 in. in diameter, and extending over each side of the frame, on which are keyed two cast-iron circular plates, one on each end of the shaft. Into each of these plates are four openings for receiving the tools which remove the bark. These tools are fixed in the plates at an angle exactly the same as in a joiner's plane. Speed is a very important item in working this machine satisfactorily. If too slow, it jams itself, and will not remove the bark; and the speed must not be under 1500 revolutions per minute to enable the machine to do its work satisfactorily. Facing the plates there is a lifting apparatus, which enables the man in charge to keep the wood close up to the cutting tools. At the same time, by means of rotary toothed gear, the wood is kept revolving in front of the barking tools, the rotary motion being supplied by the main shaft of the machine and operated in connection with the lifting gear. Two men can work at this machine—one at each side; and, if the wood is piled beside them, they can remove the bark from an enormous quantity in one day. The machine absorbs from 18 to 20 horse-power, and is capable of cleaning wood for ten tons of finished cellulose per day. It is an admirable piece of mechanism, and in many respects does its work cleverly. But, for economy of wood, the hand-barking is preferable.

Hand-Barking.

Scandinavian pulp manufacturers are not behind the times or indisposed to adopt the most modern tools in the market, nor are they slow in finding out if these tools meet their requirements as far as efficiency and economy are concerned. Hence the adoption of mechanical means in removing the bark, and its subsequent abandonment and falling back upon the old and better system of hand-barking. In the process of hand-barking, the workman is provided with a stool or trace, about 10 feet long, and sufficiently high to enable him to work comfortably. At one end of this stool is a hollow piece of wood, and at the other a spike or spur, which holds the log in position while the workman removes the bark. When it is necessary to turn the log, the workman lifts the end where the spike is, and turns the log with ease—this turning process being continued until all the bark is removed.

The first operation in hand-barking is the removal of any projecting knots or inequalities with a hatchet, and then with a draw-knife the bark is removed in a very cleanly manner—the bark being, as a rule, taken off by beginning at the root-end and finishing at the crop-end. The reason for so doing is the easier removal of the bark, and the operation is performed quicker and cleaner. A good workman will earn as much as three or four shillings per day of ten hours, which is very good pay for this class of work in Norway.

It must be distinctly understood that hand-barking does not only mean the removal of the outer bark, but also the inner bark, which is of a yellow colour, and full of minute grey specks, which, if left, it would be impossible to remove by any subsequent cleansing process through which the boiled material passes. The wood, being thoroughly cleaned of its bark, is now passed over to the examiner, whose duty it is to reject any portion of it which does not come up to his standard of cleanness—the perfect being passed over to the chopping department, which is the first process of disintegration which the wood passes through.

Before entering upon the chopping process, I may mention that all the wood is thoroughly examined, and any log showing the slightest indication of being imperfectly cleaned is at once sent back to the "barker" to be done over again.

The cleaned wood which has passed the examiner is now sawn into lengths convenient for the man at the chopper to handle. The chopper consists of a cast-iron circular plate, about 4 feet in diameter by 2½ inches thick. There are three recesses in the plate—two for the cutting knives, and one for the ripper. The ripper cuts deep enough into the wood to disintegrate sufficient material for the two chopping knives to remove. This divides the wood into small pieces, which facilitates the sorting and the boiling. The wood is not cut off square at the end, but at an angle, which takes less power, and is more expeditiously done. The cut wood falls from the chopper into a pit, where a belt elevator is working for the purpose of raising the wood up to the sorting screen. This sorting screen consists of a wooden frame with a wirecloth bottom, all of 1½-inch mesh, except a small part of the screen at the end where the cut wood enters, which is covered with a much finer wirecloth, that carries off any sand or sawdust before it enters the screen proper. This sorting screen has a sharp shaking motion, which enables the good wood to pass through the meshes of the wirecloth, and the large knotty pieces to fall over the end of the screen, where it is collected and conveyed and mixed with the bark in the soda recovery department as fuel.

The sorted wood which passes through the wirecloth now comes in contact with a fan, which blows it through an 8-inch pipe up to the boiling department. This is an admirable system of conveying material from one department to another. And when one begins to think over such a mode of conveying raw material in a cleanly manner, there is practically no end to the uses to which it can be applied. Cut straw, cut wood, and cut rags could be blown any reasonable distance with such a fan. I cannot say how it would behave with esparto, not having tried it. The system is perfectly cleanly, and the material can be blown directly into the boiler—thereby saving manual labour, and rendering any waste of fibre absolutely impossible.

Boiling Department.

In this department (like the boiling department of a paper mill) is carried on the most important operation through which the raw material passes for the production of a thoroughly reliable and satisfactory cellulose. Any blundering in this operation cannot be rectified in any of the subsequent processes through which the pulp passes, but will have to pass through the mill as defective pulp, and be sold as such, not for papermaking purposes, but as a lining which is put between the wall and the sheathing of wooden houses, no defective pulp being allowed by the pulp manufacturers to leave the country.

The form of boiler used is the upright stationary boiler, made of steel, and capable of withstanding a pressure of 200 lbs. per square inch. Attached to each boiler is a square cast-iron box, into which (by means of a pipe attached to the boiler) can be blown a small portion of the boiled wood, to enable the man in charge to determine whether it is sufficiently cooked. The quantity of cut wood contained in the ordinary-sized boiler is 17 cubic metres.

When the filling-in of the boiler is completed, the steam is turned on, and the average time from the turning-on of the steam until it indicates 120 lbs. of pressure on the boiler gauge is about 2½ hours. The wood is then allowed to boil at that pressure for 3 hours, after which the steam is shut off; and from the time of shutting-off the steam until it comes down in pressure on the boiler to 45 lbs. about an hour is occupied. The pressure being down to 45 lbs., the boiled pulp can with perfect safety be blown over to the draining tanks. The boiler contains in all 29 cubic metres—17 cubic metres of wood and 12 cubic metres of lye (7·4 cubic metres of lye at 17° Beaumne, and 4·6 cubic metres of spent lye blown from the adjoining boiler)—which complete the boiling contents.

The most important feature in the economical manufacture of cellulose, and one which the Scandinavian has carried through in a most perfect manner, is the economy of manual labour, the conveyance of the materials from one department to another being almost entirely automatic, and wholly done by mechanical means.

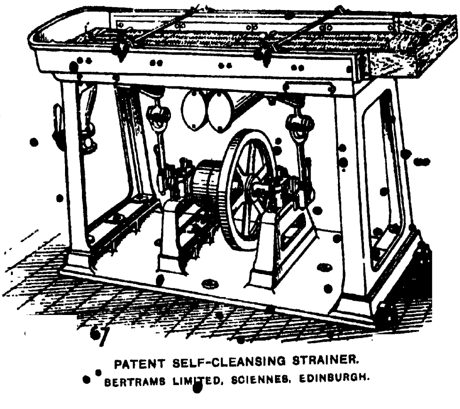
Draining Tanks.

The draining tanks are close vessels, connected with the boiler by the blow-off pipe, and having a steam-escape pipe on the top for the escape of the steam blown over with the pulp. Inside these tanks is arranged a false bottom, for the purpose of draining the pulp of its lye, which is collected, and is subsequently conveyed in pipes to the soda recovery department. The draining tanks are each capable of holding the contents of one boiler, and will thoroughly drain and partially wash the contents in a very short time, the pulp being now in a fit condition to be run to the washing department.

Washing Department.

The pulp enters this department in a dirty brown state, ontaining much matter which must be washed out. Hence the importance of having a plentiful supply of lean water for this purpose, as, if the washing is conducted in an efficient and cleanly manner, a correspondng amount of chlorine will be saved in the subsequent bleaching process, and a better-coloured pulp produced. The pulp coming from the draining tanks is passed over a series of sand-traps, with skimmers, which catch a considerable amount of impurities of a light and floatng character. It then falls into the washing tanks, which is the first real washing process, the previous one being simply draining and flushing. Into these washing tanks is arranged a series of drum washers, which, with the addition of an unlimited supply of clean water, change the pulp from its previous dirty brown colour to a pleasant golden brown, indicating that the washing has been sufficiently done and the pulp is in a fit state to be conveyed to the straining department.

Straining Department.



PATENT SELF-CLEANSING STRAINER.
BERTRAMS LIMITED, SCIENNES, EDINBURGH.

There are various types of strainers used for straining wood pulp—from the old jog strainer to the latest improvements in strainers, into the merits or demerits of which it is unnecessary to enter. Suffice it to say, that in any case the pulp must be reduced to the thinnest possible consistency before you attempt to strain it, if you desire to make it perfectly clean. I may here mention, that possibly, if we acted upon this system in straining our half-stuff at our presse-pâte machines, we would immediately obtain a much cleaner material, and with less waste. By this diluting process the good pulp is thoroughly separated from the impurities (the former floating and the latter sinking), which are conveyed to an auxiliary strainer, where any good pulp passes through the plates to the original supply, and the impurities remain, and are periodically removed and cast into the refuse heap. The strained pulp from the strainers keeps continually passing through a conical washer, where its density is increased sufficiently to be lifted up in a comparatively thick mass from the well into which it is collected. The belt elevator, which lifts the pulp, discharges it direct into the bleaching engine.

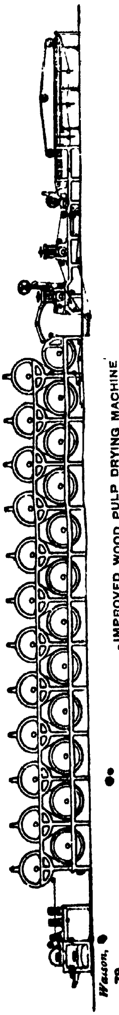
Bleaching Department.

The bleaching engines, which are made of wood, are lined inside with cement to the thickness of about 1½ inch. This is done in a very ingenious manner, as follows:—The sides of the engine (not the bottom) are filled with scupper or claut nails—that is, nails about 2 inches long, with large heads left projecting about 1 inch. The cement is laid on this, and the nails hold it in position; and I have been informed that an engine lined in this way will last for many years. When the desired quantity of pulp is in the engine, it is first washed with warm water for about an hour. The pulp is then washed down until there is sufficient oom for the bleaching liquor; it is then bleached in he ordinary way.

The quantity of bleaching powder necessary to bleach 10 tons of Sulphate of Soda Cellulose is 2000 kilogs, or 4375 lbs.—that is, when the pulp is brought up to the standard colour suitable for the English market. The bleaching being finished, the pulp is again washed with a plentiful supply of clean water until it shows no traces of chlorine. It is then emptied down to the cellulose drying machine.

Cellulose Drying Machine.

This machine, commonly called a drying machine, is practically an ordinary Fourdrinier machine, the only difference being that there is no shake motion on the wire, and no felts on the cylinders. The web of pulp is run on this machine as thick as it can be dried. It is led direct off the machine through the cutting machine, where it is cut into sheets, which are conveyed to the sorting department.



IMPROVED WOOD PULP DRYING MACHINE
BERTRAMS LIMITED SCIENNES EDINBURGH

PROPRIETOR'S OPINION.—The proprietor of this machine writes:—"I have very much pleasure in certifying that the Pulp Drying Machine is giving the utmost satisfaction. The guaranteed quantity of 100 English tons (dry weight) per week is easily accomplished, and with a steam pressure of only 12 lbs. per square inch—the low pressure thus preserving the fibre and imparting a fine felty feeling to the pulp. The machine works day and night; and during the two years it has been running I should say that not more than 100 kroner have been spent upon it as ordinary repairs. I regard the machine as one of the largest, strongest, and best pieces of pulp or paper machinery in Europe, and I have no hesitation in recording this opinion as a guide and recommendation to other pulp and paper manufacturers."

Sorting Department.

A stranger, upon entering this department when the girls are absent, would fancy that an orchestra of 150 musicians had just walked off and left their music-stands behind them. The cut sheets of cellulose are placed upon these stands, and a powerful electric light placed behind the stand. The stand being an open frame, the light shines through the sheet of pulp, showing the sorter any impurities which have been taken up or have escaped the previous cleansing process. These the sorter picks out very quickly with a small knife-like tool. This sorted pulp is called the best quality, and is passed over to the packers as such. If the pulp is for the French market, it must be perforated with round holes all over the sheet, with a view to meet the demands of the French Customs authorities.

Packing Department.

The sorted pulp is now press-packed in bales containing 125 kilogs.—that is, a little over 237 lbs. The bales are covered with hessian, and held together with wire binding, this being the only packing the goods get for shipment to America.

Soda Recovery Department.

Before closing the description of the manufacture of Sulphate of Soda Cellulose and entering upon a description of its manufacture into paper, alone and with the addition of Mechanical Pulp, I purpose giving an outline of soda recovery as it is in operation at some of the Scandinavian mills.

The lye drained from the pulp in the drainers is collected in a large tank, whence it is pumped into another tank, and at the same time strained through fine steel wirecloth, with a view to separate the lye from any fine fibre which may have escaped through the perforations in the false bottoms of the drainers. After the lye is strained it is taken over to the soda recovery department, in quantities to suit the requirements of that department. This system of soda recovery differs somewhat from anything which has previously come under my notice. In connection with the incinerating furnace is built a boiler of the Lancashire type, 20 feet long by 6 feet 6 inches in diameter, with the flues 24 inches in diameter each. The strained lye is contained in this boiler, where it is subjected to the heat of the burning lye underneath it, and to the draught of the roasting furnaces, which passes through the flues of the boiler. This system claims considerable saving of fuel. The lye from this boiler, when sufficiently dense, is passed over to the yaryan, and thence back to the incinerating furnace, where it is treated with the refuse bark and knotty rejections from the wood sorting. It is next taken to the smelting ovens, where it is mixed with the necessary quantity of sulphate of soda, and then conveyed to the causticising department, where, with the addition of lime, the well-known process of lye manufacture is carried out.

Sulphate of Soda Pulp: its Manufacture into Paper.

This pulp is very reliable in its best brands. It is naturally slightly inferior in strength, and has not so decided a silky feel or appearance as Sulphite Pulp; but it is of a better colour, and for felting, surfacing, and kindliness of feel will compare most favourably with Sulphite, and is, as a rule, much cleaner. From its nature in process of manufacture, it takes a higher place in the paper mill as a thoroughly cooked material, and one better fitted for the ordinary run of paper-making.

The best brands of this pulp are mostly used for fine printings, cartridges, and antique papers. They are better adapted for the latter than Sulphite, not being so liable to flake or cloud, and can be manipulated with greater confidence; and antique papers produced from them compare favourably with any made with other materials. Of course I do not include the high-class papers made by Cowan, Pirie, and Annandale, but the good average papers made in our writing and printing paper mills. I am of opinion that the best brands of this pulp are more valuable to the paper manufacturer than many materials used by him, as they are fully as strong as the majority of raw materials. They keep the mill clean, and there is no dust or dirt about, which, with the total absence of chemicals and the small amount of labour and power required, speaks for itself.

Treatment in the Beater.

Sulphate of Soda Cellulose, when it comes into the hands of the papermaker, cannot be called anything but a half-stuff,—not, I must say, such as esparto half-stuff, it never having been subjected to the same violent action to which esparto has been during the process of manufacture. The Scandinavian considers it a material containing all its native strength, which ought to be treated for the first half-hour in the beating engine (more like a breaking process) before the beating begins. I may here state that the beating of wood pulp is like the beating of any other raw material. The man in charge must know the character of the material upon which he is about to operate, with a view to bring to light its hidden qualities. And it is surprising how many there are in wood pulp when developed by an intelligent and painstaking workman.

The beating process must be very gradual, if the native strength of the material is to be maintained and the best possible made of it. For fine printings, it should upon no account be beaten fast, as, if so, it completely changes its character; and fast stuff on the paper machine has the appearance of marbled paper, both to look through and on the surface. It is a well-known fact that wood papers often have, and are very liable to take, a cloudy and flakey appearance, which shows more plainly that they are made of wood than any other appearance they have. But this should not be, as it can be completely avoided; and a perfectly close and uniform sheet can be made, if the stuff is intelligently treated in the beating engine by slow and careful beating. What I mean by slow beating is, not taking a long time to do the finished work, but doing it in a specified time by a judicious and gradual process. The British papermaker is a very conservative gentleman to deal with, and it is difficult to convince him that any one can do anything better than himself. But I assure you, that from my experience in countries where wood fibre has been developed and made the very best of, the mode of procedure has opened my eyes considerably on the subject; and I maintain, because I have seen it done under my own superintendence, that a very handsome soft-feeling book or fine printing paper can be produced from this Sulphate of Soda Cellulose which will compare favourably with esparto paper, with the advantage that it will carry more china-clay for its demy weight without injury to the strength or bulk, the clay having the tendency to give it that fine kindly feel so much desired by the printer. On the other hand, if a hard rattling paper is desired, the treatment in the beater must be somewhat different—that is, it must be taken at first much faster, and at the end, brushed, and cleared out, and shaken on the machine wire at a high speed. Upon no consideration should a long shake be given for these papers, as it flakes them and makes them look wild and cloudy. That is as applied especially to fine printings. But for a cartridge or antique paper, which you desire to take the character of a hand-made, and for which this stuff is admirably adapted, you must have a reasonably long shake, and not too much speed. Any one producing wood papers, and taking a special interest in making the very best of them, will, by a few experiments which cost nothing, soon find out that I am correct in what I say; and it will amply repay any one who takes the trouble to make these simple experiments with the closing of wood papers.

Of course I wish it to be distinctly understood that this article is based upon the use of the best brands of cellulose, there being a large amount of rubbish offered to papermakers which is only fit to enter into the composition of common news, and for any better class of paper is perfectly useless. The pulp must be of the best reliable brands, and hand-sorted. Such pulp is almost perfect in cleanness, and uniform in colour and strength. The lower qualities are either made from inferior wood, or mixed with imperfectly cooked stuff, which in both cases contains a great deal of dirt, which partly comes from that resinous film which surrounds the knots. It is of so minute a character that no straining will clean it—it generally being of a gummy nature, so that when it comes to the calenders of the paper machine it magnifies 500 times, and shows up in spots, which clearly prove broke, and consequent bad retree. Hence the nuisance to all concerned if such pulp gets into the composition of a fine paper.

Sulphate of Soda Cellulose is a good carrier of clay, size, and colour, when used by itself. I do not, as a papermaker, believe in using wood with any other fibre, as I do not think that any one can do it justice if mixed —that is, if the treatment that wood requires to bring it to perfection is so different from most other fibres. Hence the difficulty comes in, when mixed, of doing both fibres justice, and also my advocacy of the use of wood fibre alone (or certainly beaten alone) if you wish to get the full value of the pulp. It is almost impossible to give a fully detailed account of the system of practically working wood pulp as it is so successfully done in Scandinavia, as every practical papermaker knows that much depends upon the available plant, the natural surroundings, and many other things which crop up to interfere with the carrying out of details. But the few hints which I have thrown out for the production of fine papers from such a material will, I hope, be useful; and I trust my brethren in the paper trade will not think unkindly of me, or fancy I am thrusting my opinions down their throats, my intention being quite the reverse of that. I am simply actuated by a desire to give my experience, based only upon what has been actually practised under my own superintendence, and what is known to me to be correct.

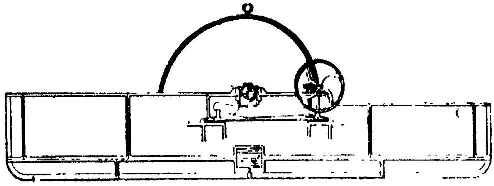
I will now devote some space to a description of the manufacture of Common Printings and News by the use of Chemical and Mechanical Pulps.

News made in Scandinavia for the English as well as the Scandinavian market is generally composed of 20 per cent. of Cellulose and 80 per cent. of Mechanical.

The paper is certainly not a handsome article to look at, but it compares favourably with the home-made article in strength, and is much more cleanly.

I will now try to describe the almost instantaneous process by which this paper is produced in Scandinavia.

LARGE ENGINE IN PLATES FOR WOOD PULP.



WATSON, 98

ELEVATION OF BEATING ENGINE

BERTRAMS LIMITED, SCIENNES, EDINBURGH

The beating-mill consists of one or two mixing engines, into which is first put 20 per cent. of cellulose, which is almost immediately broken up into fibre, then is added the mechanical pulp, clay, size, and alum, and then the colouring matter. The pulp, now being thoroughly mixed, is immediately emptied into a chest. I may here state that the pulp is never subjected to the action of the roll and plate, but simply mixed by the action of the roll, the process being a purely mixing one. The mixed pulp contained in the chest is now supplied to the conical engine in such quantity as it will conveniently take, when the whole work of refining or clearing takes place. Understand me, *refining*, not beating, as the conical engine does not, and will not, beat stuff as it is understood by a papermaker, simply because the action of the machine is instantaneous—the pulp entering at one end and passing out at the other in a continuous stream.

As a clearing engine nothing can surpass it. It does its work to perfection. But it is no more than that; and if makers of such engines would confine themselves to representing it as such, papermakers would under stand what was offered them, and know what to expect of the machine.

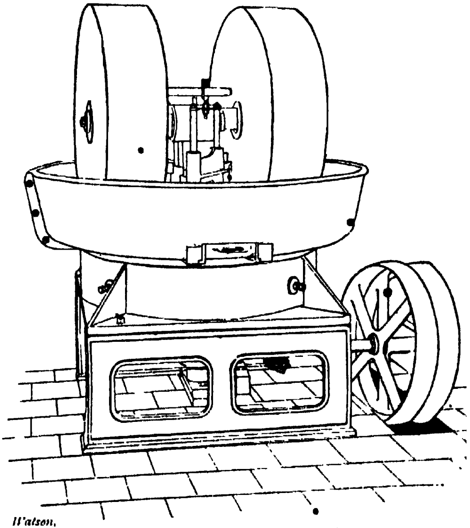
This refined pulp passes through the conical engine direct into the paper-machine chests, the production of 1000 lbs. of pulp occupying one hour only. The stuff is cleared completely from knots, and even an 11-lb. demy carries its water beautifully. This is barely what our old papermakers would call papermaking. Still, it produces an article which meets the demand of the newspaper proprietor, and serves its day and generation, although "fearfully and wonderfully made."

There is also made in Scandinavia a paper (called Common Printings) from 50 per cent. of Cellulose and 50 per cent. of Mechanical Pulp. This is a fairly strong paper, and requires the use of the engine roll and plate in its production. Still, with the assistance of the conical engine, it is produced in an incredibly short time. The great difficulty in producing papers which contain mechanical pulp in any quantity is the surfacing of them.

I may here state that upon the subject of the admixture of mechanical pulp with another and a stronger fibre much can be said. Of course the amount of mechanical depends upon the paper to be made. And if any intelligent engineer could invent a refining engine which would absorb a moderate amount of power for the work done, and still do it as well as the existing refining engines, he would confer a lasting benefit upon the users of such an engine where power is the first consideration, as there would be, practically speaking, no end to the papers which could be made with an admixture of Sulphite or Sulphate Pulp and Mechanical Pulp. But for the present we must confine ourselves to the existing appliances in the trade and our own experience.

In using Chemical and Mechanical Pulps together, the chemical must be filled-in first and well broken up before the mechanical enters the engine. If the paper contains from 20 to 30 per cent. of mechanical, the mechanical must be boiled,—not boiled as it is understood for rags or esparto, but boiled in an open tank (or, if preferred, a close one) with about 3 lbs. of crystal soda to the cwt. This has a wonderful effect in softening the mechanical —preventing the rosin from sticking in the wire, and rendering the mechanical more pliable, and more liable to be subdivided in the engine, and consequently better distributed in the paper. This is the only arrangement known to me for preventing the mechanical pulp showing up on the surface of the paper in clear specks. I do not wish it to be understood that this is an absolute cure, but it is considerably in the right direction, and makes a material difference in the surfacing and general appearance of the paper. If the quantity of mechanical exceeds 30 per cent., then, upon economical principles, the papermaker must decide whether he can or can not boil his mechanical pulp—that is, for casings, grocery, and small hand-papers, where the percentage of mechanical pulp is so high.

The surfacing of papers which contain much mechanical pulp is certainly a difficult operation. Where boiling is not resorted to, you may give them a comparatively good surface on the machine; but, when they are cool and the electricity leaves them, they again get rough. The mechanical pulp seems to rise up on the surface, which gives the paper a rough feel and woody appearance, and it at the same time throws off a sort of fluffy or floury dust, which is very objectionable, and is much complained of by the paper merchant and the printer, as it does considerable injury to the printing plant, and is a great obstacle in the way of producing a perfectly printed sheet. But, unfortunately, to a certain extent this cannot be avoided, for the simple reason, that so long as an uncooked material enters into the composition of any class of paper, so long will it show up in all its natural qualities; and, as to mechanical pulp, through whatever mechanical process you pass it, it still retains all its primitive character. You may reduce it to the finest possible fibre by the kollergang, the beater, or the refiner. Still, it, or a great portion of it, will float and come to the surface during the process of manufacture into paper, and show itself in clear specks, which, when dried, will twist, curl, and stand on end, do what you will. Certainly, it is the nature and character of the fibre to do so, it not having been subjected to any chemical process to change its character and make it a more pliable and obedient article in the hands of the papermaker.


Watson, 83

KOLLERGANG OR EDGE RUNNER.
BERTRAMS LIMITED SCIENNES EDINBURGH.

ESPARTO PAPERS.

Before closing the details of the manufacture of wood papers and entering upon some details of esparto paper, I may here state that I will, further on, treat upon the machinery which is considered best adapted for wood papers.

Esparto has experienced many changes. Since its introduction to the paper trade the quality has very considerably deteriorated. You now seldom see the fine, clear, golden article which was first introduced, but more of the coarse, rooty, and impure kind. I am speaking generally. The good article can yet be had, but at an increased cost. Hence the necessity of the esparto, of whatever grade, being thoroughly examined, much depending upon its condition and quality as to whether it will meet the requirements of the paper manufacturer and produce the article desired. One of the great evils which the papermaker has to contend with is the large quantity of loose esparto contained in a consignment, it being a fruitful source of conveying dirt into the mill, and assisting to pollute the clean material which is received in bale. I believe that, according to contract or use and wont, the papermaker does not require to take more than 10 per cent. of loose along with any consignment; but this quantity is often exceeded. It is a matter, therefore, which ought to be considered by the papermaker.

Esparto should never be allowed to get wet or damp before baling, as there is a danger of it heating, which renders it liable to take fire; or, if allowed to remain long in a damp condition, it will mould and get black and rotten, which will render it perfectly useless for papermaking purposes. Consequently esparto should be at all times stored under cover, and kept off the damp ground. If you wish to keep it in such a condition that you can draw upon it at any time with confidence, see that you have it as clean as it can possibly be imported.

The Esparto family is of various grades, which are described as under:—

Spanish Esparto.

This esparto may well be considered the "aristocrat, as it is utilised in the manufacture of the best papers, for which it is admirably suited, it being stronger, cleaner, and bleached at less cost than the other varieties. It has, as a rule, a superior appearance, being of a pleasant amber colour, and having a hard wiry feel, with an almost total absence of weeds and roots. It is never found long and rank, but short and curly, and matured in appearance.

African Esparto.

Of the African varieties there are several, which vary in quality according to growth and situation. Possibly the Oran variety ranks as the best in quality. In appearance it more closely resembles the Spanish than the other sorts, but it is upon some occasions greatly mixed with weeds and roots, which are very objectionable, and difficult of removal. When comparatively clean and well baled, it (with an admixture of Spanish esparto) will make a very nice printing paper, soft and kindly to the feel, and which takes the type beautifully and clear.

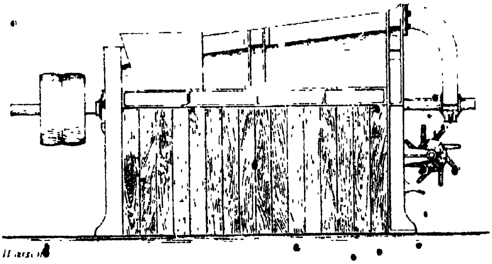
Tripoli Esparto.

This is one of the strongest grown of the Esparto family, and probably one of the coarsest. It arrives in this country in bales. It sometimes grows to a height of three feet, and is thick and bulky. It is a soft and spongy article, and contains much moisture, consequently it does not yield so well as the others.

There are several other varieties, such as Sfax, Gabes, and Susa, all natives of Africa, and more or less corresponding in character to each other. All the varieties of esparto produce two crops yearly—one which is called the winter and one the summer crop. There is a considerable difference in these espartos. The summer crop being more matured, and containing less moisture, is of greater value to the papermaker than the winter, the latter having an unripe and green appearance, and consequently of a less yielding capacity.

Cleansing Esparto.

Of late years there has been a considerable change in the mode of operation in this department. The advent of the esparto willow or duster cleared off the girls, and turned esparto cleansing into a purely mechanical process, which only served the purpose of freeing the esparto from dust and sand, leaving the vegetable impurities to be removed by a subsequent process. Consequently we will follow on until we come up to this root- and weed-removing process.

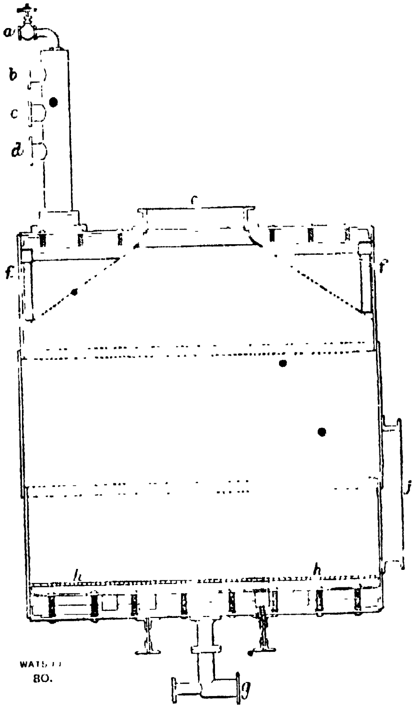


92 CONICAL ESPARTO DUSTER
BENTHAMS LIMITED SCIENNES EDINBURGH.

Esparto Boiling.

This being the process which follows the dusting, or removal of the sand and dust, we had better enter into full details of the mode of procedure in this department, as it is well known to the papermaker to be the most important one in the process of paper manufacture.

In this department every care should be taken to ensure the boiling operation being done at one time, not only as a matter of economy in chemicals and coal, but as a means of economy in fibre. If the boiling operation has to be repeated, the loss of fibre is considerable; consequently it is imperative that every precaution should be taken to avoid this evil, as re-boiling is an expensive operation.



'PATENT FIBRE BOILER'

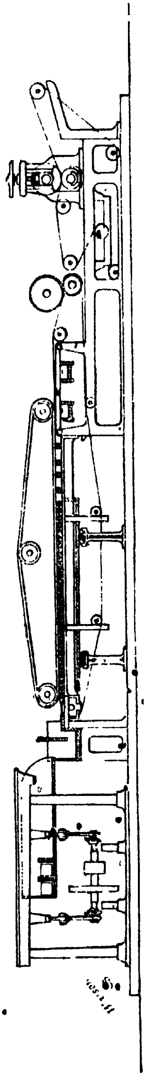
BERTRAMS LIMITED, SCIENNES EDINBURGH.

Washing and Bleaching.

I am of opinion that the engine for this purpose should be as large as possible—that is, as large as will allow the pulp to circulate with ease. Small engines cannot serve any good purpose as washing and bleaching engines. The furnish should never be denser than allows it to circulate and mix thoroughly, as without perfect circulation you have the liability of grey specks in the half-stuff machine.

Half-Stuff Machine.

We may now enter upon a description of the half-stuff machine, which has of late years undergone some considerable alterations and improvements; and I am of opinion that still further improvements could be made. I will now endeavour to describe a system, to the study of which I have devoted some time in thinking out upon economic principles. The vital part of the half-stuff machine being the strainers (the machine serving no purpose but conveying the strained pulp to the beating department), my idea of the matter would be to empty the half-stuff from the breaker into chests provided for it — the chests being sufficient in number to enable the man in charge to keep the different sorts separate. Let the chests be at a lower level than the breaking engines, and the strainers at a still lower level. Run the stuff from these chests into the strainers, and allow the strained stuff to fall into chests on the extreme ground floor; or chests could be constructed under the floor, if fall was a difficulty to be contended with. From these final chests, where the strained stuff was contained, a pump could be erected, having starting and stopping communication with the beating-engine house, so that when the beater-



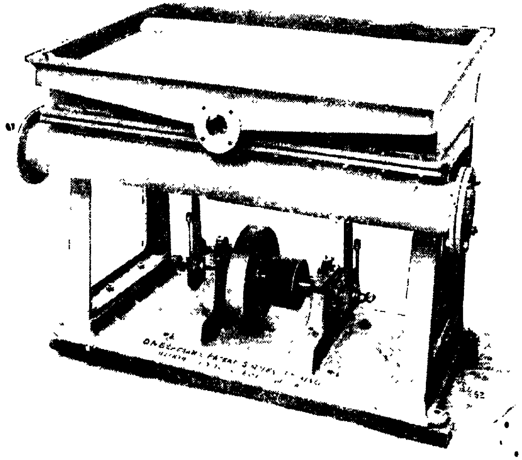
IMPROVED PRESSE PÂTE.
BERTRAMS LIMITED SCIENNES EDINBURGH

man wanted to fill-in his engine, he simply had to start the pump and let down the washer, which would bring the furnish to the proper consistency. The wire on the washer being a fine one, would ensure that no fibre was washed away.

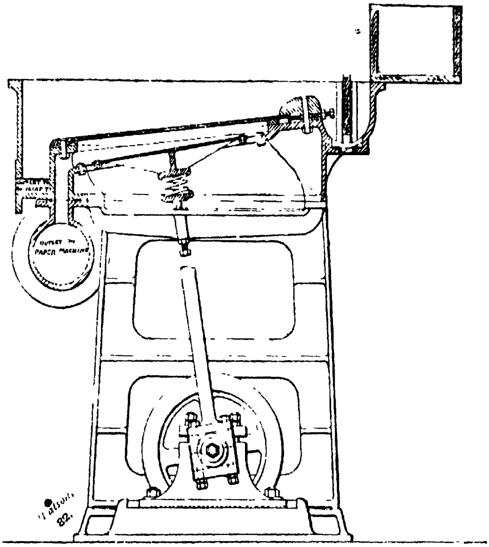
This would be a considerable saving of labour and plant, and concentrate the whole beating process into the hands of one man—that is, the beaterman. As no assistant would be required under such a system, there could not be any possible mistake in carrying out the orders given by the manager, as the man in charge would not require to be dependent upon his assistant in carrying out a portion of the details of the furnishing, which it is, as a rule, his duty to perform. I may here state, that if the strainers were of the proper type, and the stuff properly diluted, a most satisfactory half-stuff for the beater would be the result.

As to the question of dilution, it is an important one, and one which I have watched very carefully, and, from my experience in the straining of wood fibre and its most satisfactory and cleanly results, it deserves to be entered into and explained very minutely. It is a well-known fact that there is a considerable amount of waste at the strainers of the existing half-stuff machine, in consequence of the pulp coming too dense to the strainers. If the pulp was sent to the strainers in a more diluted state, there would be a more perfect separation of the impurities from the good fibre, the straining would be facilitated, and absolutely no fibre of value would be contained in the rejections.

Another very important matter in the straining, with a view to perfect cleanliness, is the system of strainers. I have refrained in previous articles from entering upon the question of strainers, as all the strainers in the market have claims with which I have nothing to do. But I may say that my own opinion, based upon close observation, is that the present type of strainer (that is, flat strainers) is wrong upon principle. It is well known to all papermakers that during the manipulation of the material (of whatever sort it may be) the impurities get the same treatment as the good fibre, and are consequently reduced in size and rendered more difficult of separation from the good fibre, and, as a consequence of this reduction in size, they are more liable to pass the plate of the strainer along with the good pulp, and show up in the paper at the paper machine. If the strainer was constructed (as I am informed it has been since I commenced to write this article) with the same plate surface, but with less distance to travel, the impurities would be more quickly washed from the plate surface and on to the auxiliary strainer, thereby not giving the more minute particles time to pass through the plate.



Strainers are, as a rule, put upon the market as guaranteed to pass so many tons of paper per week. In my opinion, the passing power of the strainer does not add to its value, as a strainer can be made to pass any quantity of pulp in a given time. But will the pulp be clean, and perfectly cleared from its impurities? That is another question. Certainly, the shorter time the pulp is on the plate surface the better it will be cleaned. It surely cannot add to the cleanness of any fibre to have its impurities dancing upon the strainer plates for half-an-hour before it is either washed off or removed by hand; consequently the flat strainer is the pulp-cleaning machine when properly constructed.



END SECTION OF SIMPLEX STRAINER.
BERTRAMS LIMITED SCIENNES EDINBURGH

Papermaker's Opinion.—A well-known papermaker, who is using this Strainer, writes as follows:—"In reply to yours of yesterday, I am glad to inform you that the Experimental Strainer fitted up here has been working continuously for the last fortnight, keeping No. 2 Machine going, passing 750 to 800 pounds per hour clean paper pulp through plates of half No. 4 and 3½ cuts. This Strainer occupies very little space, and, with its continuous overflow to the Auxiliary, I consider it to be one of the best in existence. Had my Strainer plant been less extensive I would have liked to apply it to all our machines."

It is a well-known fact, that when revolving strainers were adopted the papermaker soon found out that they had one great drawback : that was, they were continually working-in their own rejections, which in a very short time rendered the vat a mass of pollution, necessitating either a stoppage for washing, or making dirty paper. Of course the makers of such strainers soon saw that something must be done to cure, or at least mitigate, this evil, and at once introduced the auxiliary or flat strainer, to work along with the revolver by having a continuous stream of pulp passing from the one to the other, which to a great extent counteracted this tendency. But still this looks very like as if the flat strainer was the dirt remover.

MECHANICAL DEPARTMENT.

I will now enter upon the Mechanical Department, which will, I hope, be of interest to my readers, as I will try to describe what at least was new to me, and what I took a special interest in, during my sojourn on the Continent. And it is surprising, indeed, how much there is to arrest the attention. Papermaking machinery of all descriptions, which has been constructed in Scotland, can be seen at work, with a curious combination of British and foreign systems, in perfect harmony with each other, with the best results.

I at first intended to enter upon a description of the materials now used for the production of all classes of paper, from the finest air-dried to the common news and shop papers; but, upon mature consideration, I decided to omit "rags," which have already been fully described in one of my previous works called "The Practical Papermaker." And as the matter would only be to a great extent a repetition of what has already been before the trade, I have confined myself to what I consider new and up-to-date, and therefore of greater importance to my readers.

Conical Engines.

The existing conical refining engines are not at all economical. Much has been said and written as to what they can do, and as to their value as modern machines for papermaking purposes. I will try and explain my experience of these machines, which I have carefully studied and experimented with for the last two years.

A conical engine, of whatever type, cannot be used according to any written or printed instructions. It being (like the beating engine) dependent upon the material used, much depends upon the condition of the bars in the cone and in the body of the machine. It certainly will not beat stuff as I or any other practical papermaker understand the process of beating stuff with a view to produce a certain paper; but it will clear out hanks, knots, or broken paper into a perfect fibre, without the slightest particle remaining, if the machine is properly used. But when you take into consideration the enormous amount of power the machine takes when at full work, and the consequent quantity of fuel consumed in a mill where the power is all steam, it comes to be a question of £ s. d.

I had no means of accurately ascertaining the exact power taken, but I made experiments with one with a view to finding out the difference between it and the ordinary beating engine. I made the experiment when I was using cellulose alone, without the admixture of mechanical pulp. I had three beating engines of 1000 lbs. capacity each. Two of these engines were working with the roll hard on the plate, and the third one newly filled-in, the conical engine not being at work, and the turbine running easy with its load. I put the conical engine to work, at the same time lifting one of the beater-rolls off the plate. The turbine began to slow down. I then lifted the roll of the second engine. Still the speed of the turbine did not come up sufficiently to do the work until I put more water on the turbine, and then it came up to its correct speed. I then shut off the water to exactly the same amount as I put on, when the turbine again slowed down; after which I took off the conical engine without putting down the engine-rolls. But I was glad to get them down as quickly as I could, as the turbine immediately went off at a very dangerous speed.

What power it takes to drive one of these conical engines, I cannot tell—that is, when it is at full work. But this I do know: that in a steam mill it will show up very prominently in the coal account. In Scandinavia, where the power is all water, it does not come to be a serious matter, as water there is, as a rule, unlimited all the year round, and of the purest description.

Paper Machine.

I will now try to describe the system of paper machine used, and best adapted, for wood papers.

In my wanderings on the Continent of Europe I have seen, and have had under my charge, paper machines of foreign make—viz. French, Belgian, and German—as well as machines of British manufacture. But, for solidity, and steadiness in running at a high speed, none could compare with those made in our own country for the manufacture of any sort of paper; and for the manufacture of wood papers, when constructed for such, they will compete with any in the world.

Some one will probably say that I lean rather too close to my own people. But I must say that I am adhering to the truth, and giving my personal experience as a practical machineman and paper-mill foreman.

A paper machine, especially for wood papers, should be supplied with a revolving sand-trap—that is, a sand-trap supported in the centre by a beam of wood extending from one side to the other, it being kept upright by two moveable legs or supports on hinges, so that, when washing is necessary, the legs can be let down and the sand-trap lowered to the floor at one end, to facilitate the washing-out, which may be done in a few minutes. The strainers should be of the flat type, and also self-cleaning, as the revolving strainer is not at all adapted for cleaning wood fibre, most of the impurities being of a floating nature, and best washed from the surface of the flat strainer. The only fault in the present system of flat strainers is that they are too long, the dirt having so far to travel before leaving the plate surface that a considerable quantity of it is washed through the plates before it passes over them and on to the auxiliary. If the same plate surface could be presented to the pulp with less distance to travel, it would be a decided improvement, and one which would meet the requirements of the paper and pulp manufacturers.

The breast of the machine for wood papers should be high—that is, with a 40 ft. wire which will present about 18 ft. of papermaking surface. One inch of rise is sufficient, simply because the wood fibre should pass on to the travelling wire as soon as possible, with a view to prevent the mechanical pulp getting time to come to the surface and to float, after being thoroughly incorporated with the other fibres during its previous agitation. The couch-roll jacket should have a liberal supply of water—hot, if possible—which prevents the long wool of the jacket catching the woody fibres of the mechanical pulp and raising them up to the surface. The wire should be abundantly supplied with washing pipes, to wash out the fine fibres of the mechanical pulp, and thus always present a clean wire coming round to the pulp.

The press-rolls should be in three sets, for reasons previously mentioned; and I may say here, that any one adopting this three-sets-of-press-roll system should see that all the felts are of one length and one texture, as, in practical working, the new felt should be put on the first press, and when half worn-out transferred to the second press, and then finished up on the third press, which is a matter of economy in felting, as naturally the pressure on the third press is not so great as on the first and second, and the old and comparatively worn-out felts suit admirably.

I wish to say a little more upon this first, second, and third pressing system; that is, I wish to appeal to every papermaker upon this important question as to its merits and usefulness in the manufacture especially of wood papers as well as in the manufacture of papers made from other materials.

Our old papermakers insisted upon the first two cylinders on the paper machine being kept cold, and the heat being raised on the rest by a gradual process up to the extreme dry end of the machine. The meaning of this is perfectly understood, and was in the right direction. But I am of opinion, with all due respect to our forefathers, that, even at the slow speeds they were accustomed to drive their machines, the temperature of the cylinders was too high at the dry end of the machine to produce the desired result. Hence the modern paper machine, at the present rate of speed, with three sets of press-rolls and the present popular number of cylinders, will produce the article our forefathers aimed at. And when you take into consideration the materials now used in the manufacture of paper of the medium and lower grades, this addition to the paper machine will meet a long-felt want. By this system of pressing with three sets of press-rolls the temperature of the cylinders is at all times low, the paper never being subjected to that roasting process which is common with forced drying.

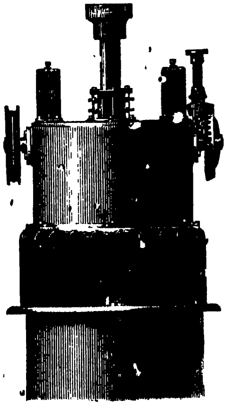
I have been in a mill where I saw a machineman drying the paper (18 lbs. demy) upon a 16-cylinder machine with 20 lbs. of steam on the gauge. I have also seen paper fully heavier than that dried with 12 lbs. of steam upon the same number of cylinders and at the same speed, but with three sets of press-rolls—the first set pressing fairly hard, the second a little less, and the third pressing slightly—the result being in the latter case an improved paper, stronger and tougher, with a considerable saving in fuel.

The drying cylinders are of the ordinary kind, but in some mills on the Continent they have an arrangement of rolls between the cylinders whereby the machineman can at pleasure miss one or more of the paper-drying cylinders, thereby turning them into felt-drying cylinders for the time being. Whether this is a benefit to the paper manufacturer or not, I leave my readers to judge.

Water-Power.

Water in Scandinavia, being so plentiful and of so pure a quality, ought to be a source of great wealth to the nation, as it naturally takes the place of coal in supplying power, and is most suitable for papermaking purposes. The Norwegian says that his country is a very poor one; but he forgets to say that it is so only from an agricultural point of view. Norway, in natural power, is exceedingly wealthy; and capitalists, of whatever nationality, who embark in manufacturing industries, will at least obtain cheap power in abundance. The natives are industrious and intelligent; the schools and other educational institutions are first-class; the climate is magnificent; and there is an upper class who, for kindness and courtesy, will stand comparison with that of any other country. There is none of the fleecing and misleading which is so common in other parts of the Continent of Europe.

The principal motor in Scandinavia is the turbine. This piece of machinery was at one time imported; but of late years the



THE "HERCULES" TURBINE.
BERTRAMS LIMITED,
SCIENNES, EDINBURGH.

Scandinavian has produced at home some very fine turbines, which compete most favourably with the German article, and are only rivalled by the Swiss and American turbines. As a rule, the water being unlimited all the year round, the turbines laid down are generally greater in power than what is immediately required of them; which means that, when extension of business is contemplated, the additional machinery is put down and connected with the existing power without any interference with the original motor.

I have visited, and have seen on my travels through Norway, many valuable water-powers, not far removed from rail and sea, which are running to waste, no advantage being taken of them. And I have often thought that if cotton, woollen, and other manufactories which depend upon steam-power were planted down beside these waterfalls, what an annual saving would be made —that is, if the raw material could be imported into Norway as cheaply as it is done into England or Scotland. At all events, the water is abundant and of the purest description, fit to enter into the manufacture of any class of goods, brewing and distilling included.

CHEMICAL DEPARTMENT.

Tub-Sizing.

Tub-sized papers are now much more common than they used to be. At one time only high-class papers were tub-sized, but now comparatively common papers are sized in this way, and, owing to the cheapness of these papers, an economical system of sizing them is of value to the paper manufacturer. For such papers I have, from my experience, prepared a cheap sizing composition, as follows:—

Two wooden boxes or tanks, lined with lead, are placed on a high level above the sizer, the capacity of each being 36 cubic feet, and each of which will contain enough size, when full, to size 3000 lbs. of paper. The contents of one of these boxes can be in use for sizing while the other is in preparation. Dissolve in each of them 1 cwt. of gelatine. Do not allow it to boil, as it will turn black, but dissolve it under the boiling point. After it is thoroughly dissolved, take 84 lbs. of starch, and mix it up in cold water to the consistency of cream; then gradually add the starch to the gelatine, keeping the solution just under the boiling point, when the starch will swell and burst up, forming Aparatim.

This composition will size paper well and cleanly; and, if the sizing is done on the paper machine, it will not stick to the calenders if rightly done.

Bleach Test.

Pound 50 grs. of bleaching powder in a mortar, put it into a crucible, and just cover it with cold water. Wash the mortar, and empty the bleaching powder in the crucible into it, adding a little hot water. Then pound them. Decant from the mortar into a burette till it contains 1000 grs. of bleaching solution. Take 1 gr. of Potassium Ferricyanide, and dissolve in half a wine-glassful of water. Now spot it on a clean white plate with a glass rod. Fill a basin quarter-full of water, add 12 drops of Sulphuric Acid, then heat. Now weigh off 78 grs. of Protosulphate of Iron, and dissolve in a basin of water. When the Protosulphate of Iron is dissolved, add cold water until the basin is three-quarters full; then add the bleach solution from the burette, stirring with a glass rod, and spotting a drop from the basin into a drop of the Protosulphate of Iron solution till it ceases to turn blue. It will take 55·4 of the burette to do this. 55·4) 2000 = 36·10 % of Chlorine.

Phlorogusine.

This, as a test for mechanical pulp, is unrivalled for delicacy. Take 2 grammes of Phlorogusine; put in a close-stoppered bottle, add 25 cubic centimetres of Alcohol and 5 cubic centimetres of Concentrated Chloric Acid (H C L). It is best to keep this solution in a dark-coloured bottle and away from the light, as the light destroys its delicate effect.

I may mention that the best way to make up this solution is to confine yourself to small quantities; that is, make up as small a quantity as possible, with a view to having the solution always fresh and ready for use.

China-Clay.

This being an article which enters to a considerable extent into the manufacture of paper, deserves some space to describe its composition and usefulness. Many people outside the paper trade have the idea that china-clay is an adultrant, and a source of great profit to the paper manufacturer. This is a mistake, as much of the beautiful satin glaze on our highly-glazed papers is in some measure due to china-clay; and the close, easily-written-upon paper, which has an even and smooth surface, is partly due to a small percentage of china-clay being used in its manufacture.

If we consider the loss of china-clay in the process of paper manufacture, we will find that the paper manufacturers who use it have not such a handsome margin from it as is generally supposed. Taking the price of the best brands of china-clay and the present price of finished paper, we come to the conclusion that china-clay is not an adultrant, but an essential material in the production of a well-finished paper.

The best brands of china-clay must be free from grit, and have all the best carrying capacity—that is, the clay should be in so finely-divided a state that it will adhere to the pulp without being separated during the process of manufacture, as, whenever an excess of china-clay is used, it will be found lying in the sand-traps, and, in fact, all over the wet end of the machine. This is deliberate waste, and, where such exists, the original quantity should be reduced, or the matter investigated to find why the fibre is not carrying the proper quantity to finish the paper.

There are several tests for china-clay, which it will be better to enumerate in detail, as follows:—

If a sample is submitted, retain it, and judge your consignment from the sample sent—that is, if the sample sent meets all your requirements. We will therefore suppose that the sample submitted will be taken as a standard.

Place 20 grains of this standard on a piece of glass along with 20 grains of the stock or bulk of the china-clay received; then rub both into a paste, and test each by the feel for grit. If there is any grit in the clay, it can be felt at once. It is also very important to judge of the colour. Place a small quantity of the standard sample and the consignment in two small heaps, as close to each other as possible, without mixing them; then press both flat at one operation with a piece of glass. The line where the two samples meet will at once indicate any difference in colour. Of course there are difficulties in judging colour in this way, as sometimes the china-clay is dyed with an inferior quality of ultramarine, making it appear to the eye to be a very handsome article. But, as a rule, these dyed china-clays are of a very inferior quality, and, in testing for grit, they are generally discovered, as they contain a certain amount of sand and dirt, which can be easily detected, and which is foreign to the best brands of china-clay. It is scarcely necessary to add that goods adulterated in this way do not emanate from the best china-clay merchants, but from unscrupulous speculators, with whom the paper manufacturer is seldom induced to do business.

If china-clay passes the above ordinary tests in a satisfactory manner, you may rest assured that you have got the article you desire and have contracted for.

China-clay is a chemical compound of silica and alumina. It is understood, as a rule, that, as the percentage of alumina in china-clay increases, the soft oily feel increases in proportion. The quality of china-clay differs much, and depends not only on the mine it is taken from, but on the cleansing treatment it receives before it is put on the market.

The analysis of china-clay may be of interest to some of my readers. It is the work of a thoroughly-qualified chemist.

Silica	46 per cent.
Alumina	40·47 „
Oxide of Iron	0·38 „
Lime	Absent.
Magnesia	Slight traces.
Potash	1·27 per cent.
Organic Matter	11·88 „

Another analysis from a different mine.

Silica	47·20 per cent.
Alumina	38·80 „
Lime	0·24 „
Magnesia	Absent.
Potash	1·76 „
Soda	Absent.
Oxide of Iron	Absent.
Manganese	Slight traces.
Water	12·00 per cent.

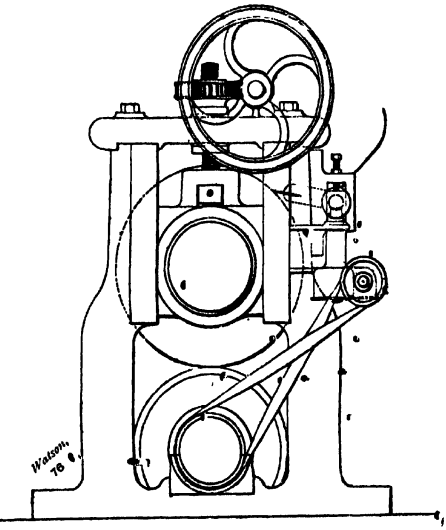
The above is sufficient to show what a good china-clay, suited in every respect for paper finishing, really ought to be.

But the most important features which the paper-maker has to consider in china-clay are its percentage of moisture, its colour, its freedom from iron, and its adhesive qualities. In using china-clay as a surfacing agent in the manufacture of paper, care should be taken that no excess should be put in the engine, as only a certain quantity will adhere to the pulp, and any excess is lost in the process of manufacture. It is very difficult to determine to a nicety the quantity which the different materials will carry without injury to their texture. But the papermaker can, as a rule, judge pretty accurately as to the quantity which can with safety be put into the different thicknesses of papers which he makes with a view to get the desired result—that is, of feel and surface—without injury to the bulk or strength.

Much could be written on the subject of china-clay; but I consider it sufficient to point out a simple method of examination, which can be adopted by the youngest workman in the mill, and which will prepare him in future for more elaborate examinations.

POSSIBLE IMPROVEMENTS.

I have many times experienced (when running the paper machine, and since I have acted as paper-mill foreman) a difficulty in bringing forward the paper uniformly-pressed at one operation to the calenders—in many cases the web of paper being over-dried at one side and insufficiently-dried at the other, the fault arising from unequal pressure with the press-rolls. It is the practice in most paper mills for the machineman to press the front side, and the machine assistant to press the back side, the consequence being, upon many occasions, an unequally-pressed paper and a complete mess at the calenders until the presses are adjusted and the paper is pressed uniformly on both sides. I would suggest, as a remedy for this evil, that both sides of the press-rolls should be connected, so that the pressing can be done from the front of the machine by the machineman alone.



PRESS ROLLS WITH IMPROVED PARALLEL LIFTING GEAR.
BERTRAMS LIMITED, SCIENNES, EDINBURGH.

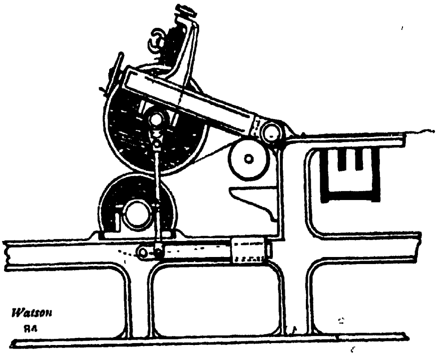
This could be managed on the same principle as a cylinder felt is tightened up—that is, with a clutch arrangement on both ends of the cross-shaft—so that, when changing a felt, the one side of the press-roll could be raised without interfering with the other side. By this arrangement, a perfect and uniformly-pressed paper at one operation would be the result, saving at every alteration of the pressing a considerable quantity of broke—thereby avoiding loss to the employer as well as annoyance to the machineman. It is in these little things that a saving can be effected. Nothing should be considered of so little importance that it is not worth adopting, when it has a tendency to produce perfect paper, and to add not only to the comfort of the work-people but also to the daily production of the mill.

I have had the question of automatic leading of the paper under consideration for some years, and have come to the conclusion that it can be done—that is, that the paper can be led automatically from the wire to the first press in the following manner:—The ordinary wet felt remains intact, and a second felt of a somewhat more open texture passes between the top couch-roll and the wire (consequently over the paper). This second felt passes on and under the top roll of the first press; that is, the paper at the first press will be pressed between two felts, the leading being accomplished on the same principle as on the single-cylinder machine. This process can also be continued on to the second or third press by a series of felts (but I do not approve of the matter being carried further than the first press, as it will make no material difference to the paper but what the other presses will obliterate), and it will certainly prevent the possibility of any fibre being wasted at the wire—the whole being carried to the first press-roll, where any broke can be cleanly collected and sent back to the beater. It also has the tendency to completely obliterate the wire mark. It does not involve any considerable alteration of plant, nor does it create any great expense, and the subsequent saving of material is a very important consideration.

If rough-surfaced imitation hand-made papers are desired, this system facilitates their manufacture, and produces the requisite article at little cost, the extent of the pressure on the first press varying the roughness of the surface on both sides of the paper.

Couch-Roll Brackets.

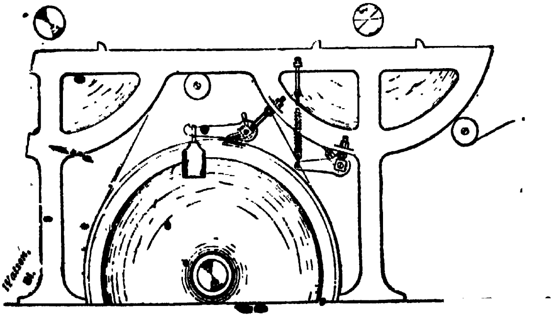
Couch-roll brackets on wide and large paper machines stand in need of some improvement, the top couch-roll being so heavy that the machinemen experience some difficulty in taking off and in putting on the top roll when changing a wire. Could not the top couch-roll brackets be made with a joint or hinge near the framing, so that the top couch-roll could be lifted clear of the wire, leaving sufficient room to lift the under roll when putting on the new wire? The top roll could be lifted with a chain-tackle, and, when the wire was on, it could be lowered down gradually and exactly at one operation into its place upon the wire, thereby saving damage being done to the wire by the twisting and shifting of the top roll to get it to go up on the wire in a parallel manner.



ELEVATION OF IMPROVED COUCH-ROLL BRACKETS.
BERTRAMS LIMITED. SCIENNES. EDINBURGH.

"Doctors" on Cylinders and Calenders.

This cannot rightly be called a possible improvement, as it is an existing one, and one which deserves the attention and consideration of paper manufacturers who have not adopted it. In mills where mechanical pulp is used, doctors on the cylinders are absolutely necessary, as, when the paper comes in contact with the heated cylinder (however low the temperature), the minute particles of rosin contained in the mechanical pulp melt and adhere to the cylinders; and where there are no doctors, the surface of the cylinders assumes a roughness which in time renders them absolutely useless for drying purposes, and causes them to pit and mark the surface of the paper, rendering it almost unfit to be flattened at the dry end of the machine. This roughness does not altogether consist of rosin, but is composed of fine fibre, which the rosin draws with it from the surface of the paper while in the act of adhering to the cylinder. Consequently the application of a doctor not only keeps the cylinder clean, but it reduces the tendency of the rosin to stick to the cylinder, as, wherever there is an accumulated mass of sticky matter, the paper has a greater tendency to adhere to the cylinders, and deposit a larger percentage, especially of fibre, than when a perfectly clean surface is presented to the paper.



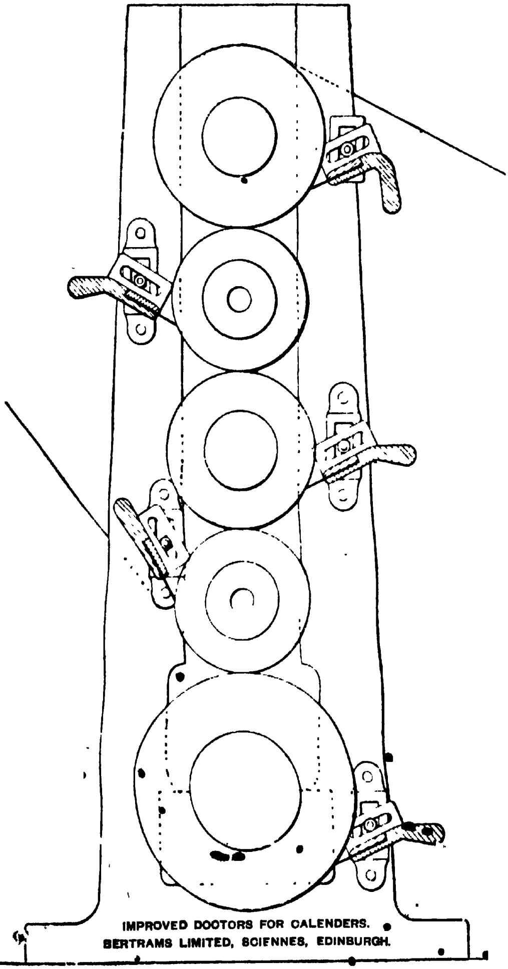
DOCTORS ON DRYING CYLINDERS.
BERTRAMS LIMITED, SCIENNES, EDINBURGH.

These doctors require to be fitted to the cylinders very accurately, and the doctor blades should not be too hard; as, in the first case, if not accurately fitted, they are liable to miss portions of the cylinder, which is very objectionable, this having the tendency to send away a portion of the web rough and "cockly;" and, in the second case, if the doctor blades are too hard, they are liable to cut into the cylinder surface, which might permanently roughen them, and render it necessary to have them turned and polished again. But, by care and a little looking after, all this can be avoided.

I generally made it a rule to note, as they came under my observation during the week, any little things which might possibly impede the progress of the work, and at the end of the week, when the mill was shut, have them put right. This system, I must say, saved me a considerable amount of trouble during the working days of the week, and was the means of preventing stoppages.

My own opinion is, that if I were a millowner I would have a doctor on every cylinder on the paper machine. Doctors keep the cylinders clean, and absolutely prevent the possibility of a piece of paper sticking on them. I have seen much broke made, and much trouble caused in the night-time, before it was discovered that a damp tail-end of the paper was sticking on the cylinder and making a slight crack on the edge of the paper, which broke at the calenders. If the crack is large, it is at once discovered; but these little ones, caused in the manner described, are very difficult to find out, especially at night.

As to doctors on the calenders, it is a mystery to me why they have not been universal years ago. I have seen, in my experience, many tons of paper sent back to the mill for no other reason than calender stamps. And, bear in mind, this was no fault of the machineman, as at the end of every break the calenders were thoroughly cleaned. Of course, paper will occasionally break at the paper machine (and there are a thousand-and-one reasons for it doing so. which are discovered by the machineman and cured by him. Still a certain amount of broke must necessarily be made before the cure is effected, and every time the paper is led through the calenders and on to the reel there will be calender stamps.



IMPROVED DOCTORS FOR CALENDERS.
BERTRAMS LIMITED, SCIENNES, EDINBURGH.

WATSON,
85.

All the Continental mills have a doctor on each roll, effectually preventing the possibility of stamps, and sending the paper on to the reel perfectly clean, which is a saving of a large percentage of broke, besides facilitating the work in the finishing department. By the adoption of doctors, the danger to the fingers is considerably lessened, and the paper easier led through the calenders.

I may also mention that I have seen, when making thick highly-machine-surfaced card-papers, such papers considerably damaged by wool marks on the surface—that is, detached threads or fibres of wool from the cylinder felt coming off with the damp paper and sticking to the calenders, and consequently marking the surface of the paper to such an extent as to render it retree, if not broke. These woolly fibres are very difficult to see during the night; but, by the aid of doctors on the calenders, this is completely remedied. In fact, the small cost of adopting doctors will in a very short time repay the paper manufacturer, and save the machineman much trouble, by allowing him and his assistant (if the paper is troublesome) to devote the time usually taken up in cleaning the calenders to the quicker discovery of the cause of the breaking, and an earlier cure.

I am aware that some mills in this country have adopted doctors on the calenders, and I am sure that what I have said as to their utility and economy will be borne out by those employed therein.

REMARKS.

I am not sufficiently a commercial man to discuss the question of foreign competition; but, as a practical papermaker, I may be allowed to ventilate my opinion, which, I may say, is based upon a close study of the matter, and keen observation as to what the foreigner is doing. The foreigner has certainly many natural advantages in the shape of unlimited motive power and comparatively cheap labour—I say, comparatively cheap labour; but I do not think this should be taken into account, as the difference in wages is so little that it comes to a very small item in the expenditure of a paper mill. I am, therefore, of opinion that the advantage of competition does not lie in that quarter, but in the foreigner's indefatigable industry, and his adoption of the most modern plant and the best mechanical appliances for transporting his materials from one department to another, which means a saving of labour, with the work done better and cleaner. His machinery is of the most modern type, and is fitted with all the latest improvements for economy of production and efficiency of work.

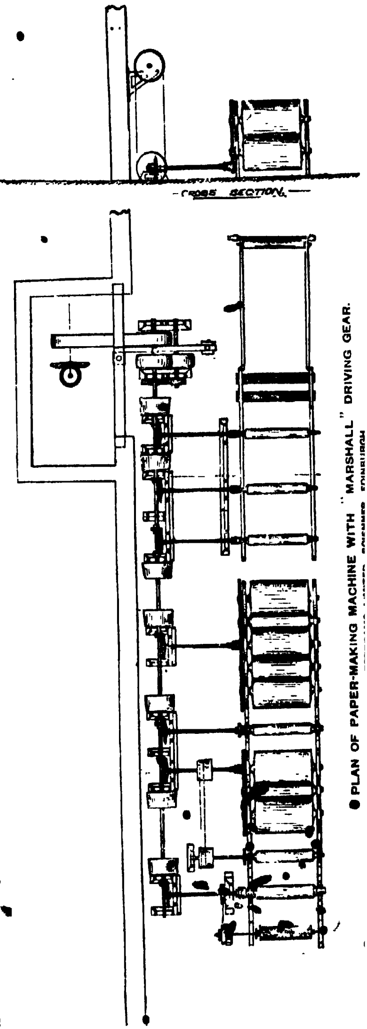
In the foreign mills you will not find any of the obsolete and ancient paper machinery which is so abundant in our own country; and I think, if papermakers would keep up with the times, by adopting more modern plant, better suited to their requirements and to the material which they are now compelled to use, we would not hear so much of foreign competition. But, so long as we go on using the old rusty tools our fathers were getting tired of, so long will we hear of other people getting in front of us and driving us out of the markets of the world.

I knew an active and intelligent paper manufacturer who would not consent to change the wheels on his paper-machine cylinders, although the number of cylinder felts destroyed every year by the wheels being bolted on to the end of the cylinders was pointed out to him. When the felt began to travel, it got amongst the wheels, and was not only cut, but greased on the edges, which continued for days to make broke by greasing the edges of the paper; whereas the trifling expense of putting wheels outside the framing would have been repaid in a very short time. The foreigner does not hesitate one moment over these things, but goes into the matter at once, where anything can be saved and economy in working assured.

Until we come up to the foreigner in the equipment of our paper mills with a view to economy and efficiency of production, we had better say as little as possible about foreign competition and its results.

I may possibly be told that my ideas of meeting foreign competition are rather expensive, and, if adopted, would mean extraordinary alterations and consequent large expense. Yes, the process will certainly be at some considerable cost in the first instance. And it is a well-known fact that there are paper machines and other paper-mill plant running at present in this country which should have been in the scrap-heap years ago. But, if we look around us, we can see at a glance that the modern and up-to-date mills are the successful ones, and that the antiquated affairs are gradually dropping out of existence, which amply proves that I am stating the truth. And, to further confirm this, we must note the fact that the foreign mills which most successfully compete with the British papermaker are the mills of most modern construction, fitted with all the latest improvements for economy of time and material, and for facilitating a large production.

I have endeavoured in this article to put before my readers all that has come under my observation relating to money and labour-saving improvements, and, before concluding, I will describe a feature which I think is worthy of notice: that is, the latest system of driving as applied to the paper machine.



PLAN OF PAPER-MAKING MACHINE WITH "MARSHALL" DRIVING GEAR.

Many of the paper machines on the Continent which have been made in this country, as well as those of Continental makers, are driven by the vertical system, which means two lines of shafting extending the full length of the paper machine. The first line, which is driven by a belt direct from the steam-engine or the turbine, as the case may be, is hung upon wall-brackets at as great a height from the floor as space will permit; the second line of shafting is placed upon stool-brackets resting on the floor. Upon both lines of shafting are conical driving pulleys, so that the machineman can alter his draws with the greatest ease and accuracy for the different thicknesses of paper which he is called upon to make. This means an enormous saving of belting, no packing being used. Connecting up every section of the paper machine is a cross-shaft, driven by bevel gearing from the under line of shafting. This method has, in my opinion, many advantages over the horizontal system of driving a paper machine. The floor space is less encumbered, and the belting lasts longer (it being vertical, and lighter belting does the work). The draws can also be adjusted with such accuracy that the steadiness of the various sections cannot be excelled. With the horizontal system, we have the pulleys covered with pieces of felt, which continually keep coming off or sticking to each other, and forming lumps upon the pulley, thus making a very unsteady drive, which, if it does not actually cause broke, makes "cockly" paper, the tension of the paper not being uniform.

Of course, when I mention the under-line of shafting on stool-brackets, it must be understood that I do not mean a continuous line, but a broken one—a break at every section. I may here also state that a machineman (when he becomes acquainted with these draws, or the changing of them) can with the utmost accuracy set them all for the paper he is about to make before he starts his machine, which means a clean start-off, without any changing of draws while the paper is running into the pit.

I now feel inclined to finish this article with a few remarks which may prove useful to my young friends in the paper trade, and which will be devoted to them and their interests. I may say that the young papermaker of the present day has to contend with a class of difficulties almost unknown to our forefathers. In addition to being a skilled papermaker, who must have a good practical experience in the use of all the most modern and up-to-date materials which enter into the manufacture and composition of fine papers as well as the commoner sorts, he should also be able to understand enough of chemistry to be in a position, at least, to conduct simple experiments and tests connected with his business. Many mills cannot afford to keep a thoroughly practical chemist (not having sufficient work for one), but at the same time find it necessary to have some one on the premises who is capable of conducting these examinations with a degree of accuracy, and who is able to determine correctly if they are being supplied with the article contracted for, and what is best and most economically suited for their requirements.

The young papermaker who has an ambition to rise in his profession has many difficulties to contend with—many more than his predecessors had—in consequence of the frequent changes that are taking place, which are of a varied character. In the days of our forefathers, a man who had sufficient education to read and write and be able to figure a little, combined with a thorough practical knowledge of his business of papermaking, was eligible to fill a position of responsibility and trust in the mill. And I must say that, judging from the old papermakers I have seen and those I have heard of, they were shrewd hard-headed Scotsmen, with their heads screwed on the right way. It was in these days that paper was made that proved the lasting article. But things are now very much altered; and if one wishes to get on he must move with the times, as what was suited to the requirements of the old papermakers will not, and does not, satisfy the modern paper manufacturer. Hence the young papermaker must ask himself some very important and vital questions as to his future guidance, such as, What do I require, independent of my practical knowledge and skill in my business of papermaking, to fit me in an efficient manner to fill a position of trust and responsibility in a mill?

Well, I will try to give you the benefit of a little of my experience, some portions of which I have a lively recollection of gaining. You must not get the idea into your head that the life of a papermaker who has spent much of his time abroad has been a bed of roses, as it is by no means such. You have, first of all, the language of the country to contend with, and the nature and character of the natives to study;—that is, if you wish to get along with them, you must not only learn to like them, but you must learn them to like you. And when that is accomplished, the whole matter is plain. Wherever you are placed, you will require to have a fairly liberal education, and an ambition to thoroughly master the practical details of your business of papermaking through every stage. You must not only study how any given part of your work can best be done, but how it can be so done with the greatest economy. This economy must not only be applied to great undertakings, but also to the most insignificant details in the working of the mill. Nothing which comes under your notice should be considered of so little importance as to be overlooked or neglected, as the times we live in demand the utmost economy. There is such a small margin of profit in the manufacture of paper at the present time, that the economy which was necessary under former circumstances is now of much greater importance. When prices for the manufactured article are so low, the profit comes out of the economy, or rather the economical working, of the mill. This economy does not only mean the actual saving of material which might go to waste, but also consists in producing the best possible article in the shortest possible time, and making the very utmost of all the materials entrusted to you to operate upon.

To rise in your profession, you will find it necessary, in the first place, to possess a knowledge of the raw material, and, if you have a tendency in that direction, you will find it a most interesting study. Get samples of the various sorts of rags; examine them—their texture, their character, their strength; form your own opinions upon them; then consult one who is older than yourself, and whose experience warrants him in guiding you if your opinions are at fault. You should also acquaint yourself with the various processes through which esparto, straw, wood, and other fibres pass. Experiment for yourself at your home. Do not act rashly, but take time; and, whatever the question be, think it out, examining not only the *for*, but the *against*. Be at all times courteous and civil to the workmen who are older in the business than you, and listen attentively to whatever opinions they have formed of anything new which has been adopted in the mill. Examine the matter in question, and see if your own opinions coincide with theirs, and judge accordingly. Upon no occasion set yourself as an authority upon any subject until you are thoroughly matured and fully understand what you are talking about, and even then you must be very careful. I strongly advise calm plodding, careful study and observation, and quiet unobtrusive manner, as a sure means of success.

There are many things upon which one could advise the young papermaker, but these can best be discussed as the occasion demands; and, in whatever position he is placed in the mill, he will always have an old head convenient, who will at all times be pleased to get him out of a difficulty and advise him for the best. Avoid all inclination to get speedily out of the mill. The sound of the bell comes quickest to those who are most interested in their work; and, by such exemplary conduct, you will not only be a pattern in stimulating others, but will yourself be commended.

I might stretch out this article to unlimited dimensions, but it would serve no good purpose; I have conveyed my ideas and experiences in as few words as possible; I have adhered consistently to my own experiences, having neither taken from nor added to them, but have given them as best I can; and I hope that they will be received in the same spirit as they have been offered.

HIGH-CLASS DUPLEX PAPER.

To produce a high-class Duplex Paper, the old system of running a stream of coloured pulp over a brown or grey ground has been much improved upon. The new method makes a perfectly uniform paper, completely free from lumps or inequalities.

The paper machine for the production of high-class duplex papers is a combination of the ordinary paper machine and the cylinder machine, with this advantage, that the cylinder machine can at pleasure be left standing while the paper machine can go on and make any ordinary paper. The duplex part of the machine can be attached when desired.

This machine consists of the ordinary paper-machine wire and wet felt; but, instead of the paper passing on from the wire to the wet felt proper, it passes on to a felt directly above the wet felt, and placed between the couch-roll and the first press-roll. This felt has an independent drive and no press-rolls—it being simply a carrying felt to convey the pulp from the wire on to the entrance to the first press, where it is joined by the layer of pulp from the wet felt proper, which receives its supply of pulp from a drum or cylinder underneath the wet felt, exactly the same as on a cylinder machine. The two layers of pulp meet each other at the first press, where they are joined together, and carried on the machine to the dry-end as a perfect duplex paper. The colour can be arranged to suit the papermaker. He can run any colour he chooses, both on his wire and on his cylinder—the top side being one colour and the under side another.

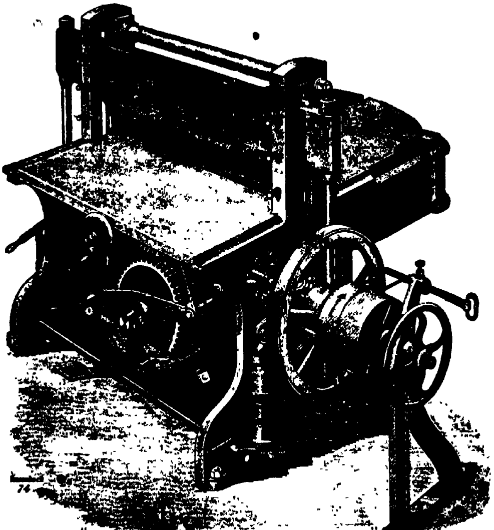
I have seen an endless variety of coloured papers made by this system, and some of them for envelopes, which for opacity and beauty could not be surpassed. This is an addition which can be made to any paper machine at so trifling a cost that (taking into account the beautiful papers which are produced by it) it is not worth considering. The beauty and utility of the system is, that any tint you desire can be given to either side of the paper—not in the rough and spotty way which is done with duplex wrapping paper, but in such a perfect manner that it is impossible to detect where the two colours come together.

The favourite colours used are mottled under side—that is, mottled grey, mottled red, and a great variety of mottled colours, with blue, red, green, and, in fact, every possible shade of colour on the upper side. These papers, when made from wood fibre, have a handsome appearance, and are very strong, and well adapted for a high-class envelope paper, as well as being a novelty in fancy note paper.

The fine brands of wood fibre, when properly treated, produce an astonishing variety of papers, for which the character of the material is well adapted, and into which it can be utilised with the greatest economy. Envelope papers, when made of this material, have all the best qualifications which they should possess—that is, great strength, absolute opacity, and a surface appearance which takes the eye admirably.

FINISHING PAPER.

The finishing departments in a Continental paper mill are conducted on somewhat different principles from those of our home mills. As a rule, there is no machinery in the finishing house except the guillotine and the folding machine. The cut paper is placed upon a waggon at the cutting machine, which, when full, is conveyed mechanically by a wire rope to the finishing house. The man at the cutting machine sets this waggon in motion, and, upon its arrival at the proper place in the finishing house (where it comes in contact with a check lever, which operates upon the main drive of the rope by changing the belt from the driving pulley on to the slack pulley), the waggon comes at once to a standstill, is immediately unloaded, and then sent back by



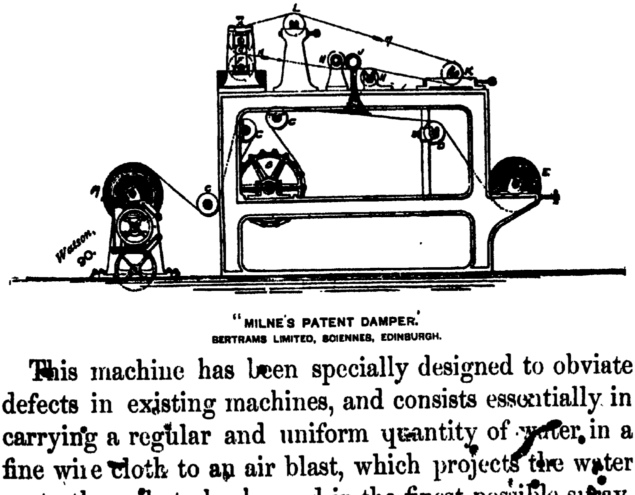
"IMPROVED GUILLOTINE CUTTING MACHINE."
BERTRAMS LIMITED SCIENNES EDINBURGH

reversing the gear. Of course this system is only applicable to mills constructed upon the most economical principles for the saving of time and labour. The paper is now given out to the girls, who sort it much in the usual way; only, where there is no folding machine, each girl must finish her own paper—that is, she overhauls it, folds it, places it down in front of the tier, and in some cases (that is, if the weight of the paper is not satisfactory) she must weigh every ream as it is finished, and report the result to the head finisher, who advises as to what shall be done. Notwithstanding all this routine, the girls make very good wages—in many cases much better than our girls at home. There is very little tied paper sent out either from the Scandinavian or the Russian mills, for the reason that the former is press-packed for shipment abroad, and the latter pressed for the Russian markets—many of the mills keeping hundreds of tons of paper in stock until the annual market at Nijni-Novgorod takes place, when the whole is sent off and sold there.

Paper made on the Continent has, in the finishing department, to be clearly and distinctly marked "Manufactured in Norway," or "Manufactured in Sweden," &c., as the case may be; and I must say that the Scandinavian carries this out to the very letter. Foreign paper may be sold in the British market as of home manufacture, but, as far as I have seen, the fault is not the foreigner's, for he honestly carries out the Customs regulations.

Web Calendering Department.

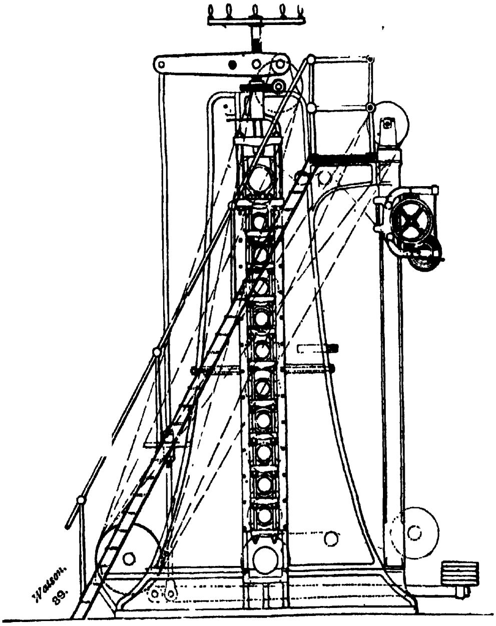
In the calendering of paper upon the Continent and in our home mills there has been a very marked advancement indeed, as not so many years ago it was considered almost impossible to calender a full width of paper (say 60 in. or 70 in.) satisfactorily. But of late years all these difficulties have been overcome; and one of the largest paper-mill engineering houses in Edinburgh is, and has been, supplying the trade with super-calenders, which, for efficiency in working, the quantity of paper glazed, and the small percentage of broke, compare most favourably with any such machines made on the Continent. And, with the universal cry for more surface, the results with these machines are astonishing. It is a well-known fact that, finish paper on the paper machine as you like, the surface has always an inclination to come back, and this is so to a greater degree when the surface has been imparted to the paper while in a very hot state.



"MILNE'S PATENT DAMPER."
BERTRAMS LIMITED, SCIENNES, EDINBURGH.

This machine has been specially designed to obviate defects in existing machines, and consists essentially in carrying a regular and uniform quantity of water in a fine wire cloth to an air blast, which projects the water on to the web, to be damped in the finest possible spray. The advantages claimed are—(1) The range of damping power is very great, and can be regulated from almost *nil* to a very large quantity, while in existing machines the range is very limited, and not easily regulated or kept uniform all over the web; (2) The damping is quite uniform all over the web, as, from the construction of the machine, it cannot be otherwise; (3) It is easily and quickly regulated to give the required amount of water, and when once set cannot be deranged; (4) It can be applied to the web at any angle, and to both sides if necessary; (5) It is simple in construction, easily understood, and operated without difficulty.

I have not the slightest hesitation in saying that, in producing a perfect super-calendered paper, the damping of the paper is the most important part of the operation, and ought therefore to be properly and intelligently carried out. Taking the roll of paper coming from the papermaking machine, and containing the amount of heat it generally does (even although means are taken in an ordinary way to extract the electricity and heat before the paper is wound up on the roll), it is most advisable that the moisture should not be imparted to the paper until it is cooled. For such a purpose, I would advise that there should be at least one cooling cylinder, or preferably two, on the damping machine, constructed in a similar manner to damping-rolls, but having cold water inside. This would have the effect of cooling the paper, and, when the moisture was imparted to it, it would not be absorbed by the heat which otherwise would be in the paper. Little heat as the paper may contain before damping, when wound up into a solid roll it becomes greater, and the moisture is absorbed. I am not acquainted with any better method of damping paper for the super-calender than by a roll running in water for moistening the one side, and Annandale's spray for the other. This spray-damping is an admirable system, the moisture being so finely distributed; and the perfect absence of drops or unequally damped paper renders it a machine which can be used with confidence, and which requires little attention when in operation. To obtain this, however, I recommend that the water jets be fixed by nuts, so as to keep them in position.



IMPROVED WEB-GLAZING CALENDER WITH 12 ROLLS.
BERTRAMS LIMITED, SCIENNES, EDINBURGH

The super-calender is now built by our own engineers in various styles, but for stability I prefer the double-jawed bracket, having from eight to ten rolls, half of that number being of cotton. There are rolls of woollen paper and brown and white linen paper, but I think the raw cotton is the best. I recommend that the diameter of those for esparto papers be larger than when wood papers are used, as, the higher the finish required, more moisture has to be imparted to the paper. And as I consider that esparto papers are more apt to be injured in the bulk, therefore I would advise that the rolls be larger in diameter than for wood papers. Most of the Continental engineers construct these calenders with automatic feed, which however is, in my opinion, more a hindrance than a benefit. Super-calenders are now brought to a high state of perfection, being fitted with numerous labour-saving appliances, such as that for lifting up the roll of paper by a simple arrangement on the planing machine, and the reversing-motion system, which enables the man in charge to place the roll of paper about to be passed through the calender in any desired position to suit the draw. An eight-roll calender should have at least two steam-rolls, and, with a well-damped paper and high-pressure steam in these rolls, the most satisfactory results will be gained. Of course it is well understood that paper which has to be super-calendered must be very carefully made. The web must be of as uniform a thickness all over as possible. Thick edges will often destroy the glazing, or prevent a uniformly-glazed sheet. The deckle edge should also be carefully trimmed, to prevent projecting fibres from sticking to the rolls.

Friction Calenders.

A great many of our envelope papers are glazed by means of friction calenders, which are now being built combined with rolling calenders—that is, when friction-glazing, three rolls are used for the operation, the two cotton-rolls on the top of the friction-roll being jammed down so as to take up any deflection of the friction-roll. In this process, as also in the rolling, satisfactory results depend upon the damping; and I strongly advise that the paper be damped according to the finish wanted. I have seen very high surfaces gained when the water was almost forming in small worms before the friction-roll, and the friction-roll heated up as hot as possible with high-pressure steam. This seems to me to act instantly, like a smoothing-iron on a well-prepared shirt front.

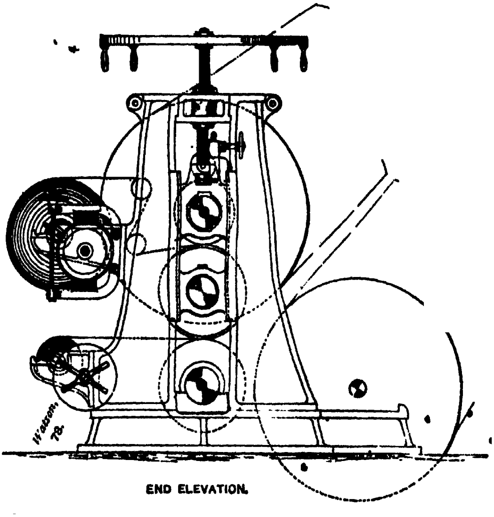
The power necessary in friction-glazing is very great, and you may reckon that to friction-glaze a web of paper, say about 60 in. wide, at least 50 horse-power is required. I recommend that the driving of the friction-roll be done by belts, as I have seen, in the case of a highly-glazed paper which had been moistened accordingly, and where the roll was driven with wheels, the pitch of the wheels show up on the surface of the paper. This, of course, is not of so much importance in common papers, but in high-class or envelope papers it is very objectionable.

As to the amount of slip, I consider that, for the average friction-glazed papers, this should be about 2½ to 1. The cotton-roll below the friction-roll should be made of the very best quality of raw cotton; and, whether the calender is used for friction or rolling, it is absolutely necessary that such cotton or paper rolls should be re-pressed three months at least after starting, the duration of the rolls being thus greatly increased, and a continuous uniform surface given to the paper when the rolls are in good order.

Hydraulic arrangements have been applied to these calenders, so as to keep the rolls separate one from the other while the calenders are not at work. These I consider very good and necessary, as, after a mill has been cooled down, the chilled rolls retain their coldness, and, when the mill re-starts, the warm atmosphere condenses on these cold rolls, runs round to the joints, and rusts and otherwise damages both the cotton and the chilled rolls. The arrangement for lifting them free from each other is very simple, and can be worked with the utmost ease by the attendant.

I am aware that calenders have been imported into this country from Germany, which I deplore, as I am confident that, for economy and efficiency, Scotch engineers can produce, and are producing, super-calenders and friction-calenders which cannot be surpassed; and, from those which I have seen and heard of made by them, little can be desired beyond their production.

The German calender may at first sight appear very attractive; but when it comes to the actual working, or to the production of a perfectly-glazed paper, it is quite a different affair. Their calenders are, in my opinion, of too light construction, having no solidity about them; consequently they soon get out of order, and come to be very costly in upkeep.

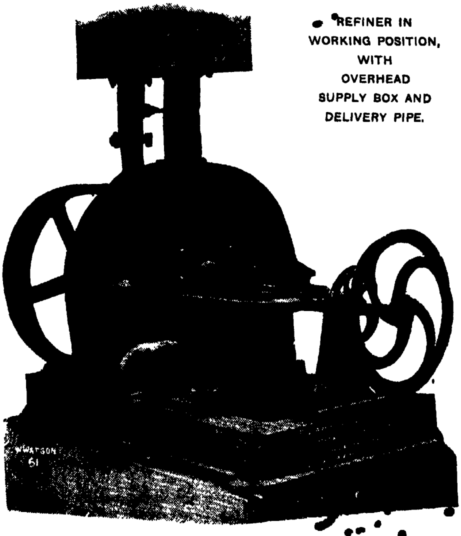


END ELEVATION.

IMPROVED FRICTION GLAZING CALENDER.
BERTRAMS LIMITED, SCIENNES, EDINBURGH.

PEARSON AND BERTRAM'S REFINING ENGINE.

By the kind permission of the Ellangowan Paper Company I was allowed to visit their works, and there saw the new refiner at full work. The machine is very compact, occupying little floor-space, and certainly having no expensive foundations. As the machine has been built with a view to efficiency of work and economy of power, we will hear more of it in the near future. What principally attracted my attention was the easy, cool, and steady working of the machine. There did not seem to be any of the hard grinding of metal which exists in the conical engine. The engine seemed to be brushing away without any effort, and discharging a cleared-out pulp, which I examined very carefully. I could not find the slightest trace of knot or inequality of any kind; and, judging from the paper being made from this refined pulp, nothing could be desired which the machine did not accomplish. Being thoroughly satisfied with the quality as well as the quantity of the work



REFINER IN WORKING POSITION, WITH OVERHEAD SUPPLY BOX AND DELIVERY PIPE.

produced, I now directed my attention to the power absorbed. The machine was passing a continuous stream of refined pulp, sufficient to keep any paper machine at full work, with a varying power of from 28 to 30 horse. If this can be maintained, the machine, I must say, has a great future before it, especially in mills where a considerable quantity of mechanical pulp is used, as the subdividing qualities of the machine are admirable, the fibres, upon close examination, being in such a finely-divided state. By that action which is peculiar to all refining engines, and which seems to be done by this machine in a most perfect manner, there is no maiming or cutting of the fibres, but a splitting or dividing process, which, while making the fibre sufficiently fine for the paper desired, does not interfere with its native strength or appearance when formed into a sheet. Upon examination of the strainers on the paper machine, there was a total absence of knots, hanks, or inequalities, or of any unrefined pulp: the whole mass seemed to have been operated upon in a most cleanly manner. This, I must say, is one of the valuable points to be considered in the refining engine. It supplies the paper-machine strainers with a pulp which will pass a finer cut with ease, simply because there are none of the hanks and knots continually accumulating upon the plate surface, which is a natural consequence of stuff emptied to the paper machine direct from the beater, and which continually keeps choking up the plates, causing variations in the thickness of the paper. When the plates are rubbed, or the accumulations on the plates disturbed, a mass of dirt escapes, which produces a considerable quantity of dirty paper; whereas, in the perfectly refined pulp there is nothing to choke up the slits, and any dirt in the pulp is washed away to the auxiliary strainer.

PAPER-MACHINE WIRE

This being the most fragile and delicate part of the paper-machine mountings, it is necessary to handle it with great care, as any damage it may get in the act of putting it on the machine may materially affect its life; and, as a rule, if the wire does not last out its time, or produce a given quantity of paper, the manufacturer of the wire is taken to task for its inferior quality, when possibly the evil was beyond his control.

I must certainly admit that wires are introduced into this country composed of differently-blended metals, which have an influence upon the longevity of the wire. If a wire is made of the very best metal and is of the best workmanship, it will give highly satisfactory results. I do not think it is right to value a wire according to the length of time it is on the machine. I am rather inclined to estimate its value having regard to the quantity of paper it will produce. This I am sure is the most just method of valuation, both to the paper-maker and to the manufacturer of the wire. Of course a new wire could be put on a paper machine, and, owing to circumstances, might be on the machine for many weeks and produce very little paper—the wire meantime deteriorating in value. Under these circumstances (which are, however, of rare occurrence) the life and the production could not be taken as a basis.

The quantity of paper a first-class wire will produce is a matter which it is difficult to determine, and it is very doubtful where the mean can be computed.

With a view to my writing on this subject in an intelligible manner, Messrs George Christie, Limited, Glasgow (one of the largest firms of paper-machine wire manufacturers in Scotland), afforded me every facility to view their extensive works, and ascertain how it was possible that a wire could be termed imperfect when it reached the paper manufacturer—that is, by imperfect weaving, imperfect wire-drawing, and damage in transit, as well as imperfect packing. All paper-machine wires are examined before seaming, or, as the wire manufacturer calls it, "coupling." If any flaw is discovered, that portion of the web of wirecloth is rejected, and laid aside to be sold as washer covers, &c.

I am told that at one time in the history of the manufacture of a paper-machine wire—or rather in the drawing of the wire—much difficulty was experienced in getting the fine wire drawn perfectly round. This difficulty has of late years been removed by the wire being drawn through diamonds. The effect of comparatively flat-drawn wire was that the sharp edges cut one another, and, as a natural consequence, the wire broke out in holes much sooner than might have been expected. All this has been avoided; and now, in manufactories where the most modern plant has been adopted, and where only the best workmen are employed, a machine wire can be turned out absolutely perfect in every respect.

Still there are many fruitful sources of damage to which the wire is subject; and these are occupying the attention of the wire manufacturer, as far as he can control the matter. Instead of the old system of nailing-up the packing cases, not only the lids, but the sides and the bottoms, are now fastened by screws. This is certainly a great improvement, as many a wire has been irretrievably damaged by a nail taking the wrong direction and entering the wire—the motion in transit making such a hole that the wire was in many cases unfit to be put on the machine. Again, we have an evil which is even greater, and completely beyond the control of either the maker or the consumer: that is, a package containing one or more wires being dropped on end. The effect of this is to wrinkle the wire or crease it in such a way that it will not live its time, and proves most unsatisfactory both to the paper manufacturer and the wireworker. In a large mill where I acted as foreman, I arranged that no wire cases should be taken off the railway waggons until I had examined them; and, if any damage was apparent, I only took delivery at the railway company's risk. If this plan were adopted in all mills, there would be less cause of dispute with regard to the delivery of goods in perfect condition.

I will now enter upon the difficulties the papermaker has to contend with in the working of the wire. There are many diseases to which the wire is subject, and many cures for them. The wire manufacturer may, with the utmost confidence, send out a wire which he believes to be a perfect piece of workmanship; and yet, when the papermaker comes to handle it, he finds many difficulties. And, in explaining this, it will be better to start at the beginning, so that it may be intelligible to all concerned.

Therefore we will suppose that the old wire has been cut off the paper machine. First, put a man and a boy to remove the old jacket from the under couch-roll and put on a new one, then two men at the vacuum boxes, and two men at the tube-rolls, leading-rolls, and the save-all. This division of labour facilitates matters, and much time is thus saved in changing a wire. I do not think that much cleaning should be done during the removal of the various parts of the machine; it had better be done in the building-up, as small particles of metal from the machine-room floor often adhere to the rolls and the save-all, which are best removed in the building-up of the wire. In the action of building-up, if the same division of labour is studied, a considerable amount of time will be saved, which is all-important in the present day.

We will now suppose that the wire is hung on the under couch-roll, and the breast-roll and all the vacuum boxes, tube-rolls, leading-rolls, and save-alls are in position, and the wire practically ready to start. Now run the wire for a few minutes without the action of the guide, which will show you at once if the wire has any tendency to run to one side of the machine. If the wire has any decided inclination to do so, it at once indicates that there is something wrong. Some of the wire-rolls are not parallel or are off the level. The machineman will soon find this out and put it right. Now put the guide in motion and run the wire empty for a few minutes, and, if all is right, start up and get the paper on. It is a well-known fact that a wire will run steadier when the paper is on than when it is off. This can only be accounted for by the strong vacuum on the boxes, which (if all the wire-rolls are in right position) will have a steadying effect on the wire. It has often been noticed by the papermaker, that so long as the paper is on the wire it will guide very steadily; but when the wire is bare, it has a tendency in some cases to run to one side of the machine. The reason of this I was long in discovering, but I found it out at last. I had some considerable trouble with this in more than one wire, and had tried many experiments with them, all of which were of no use, until upon examining the seam of the wire I found it to be going fast on the back side—that is, the back side of the seam was ¾ in. faster than the front. I now thought that probably this had something to do with the wire running off when the paper was not on it. I therefore straightened the seam in the same way as you would straighten the seam of a felt. After that was done, I had no more trouble with the wire; and I have made it a rule ever since to keep all my wires straight in the seam. Of course this must be delicately done about, as a wire will not stand the usage a felt is subjected to in the straightening process.

Another matter which has been a source of much trouble to the papermaker is the wire filling-up at and behind the seam. This is a grievance which should be properly ventilated by papermakers who are troubled with it. The cause is assigned to a deposit from the pulp; and this is perfectly correct. Some will say that if it is a deposit from the pulp, why does it not deposit all over the wire instead of in one particular part of it, and why are some wires absolutely free from such deposits? Such questions one would naturally anticipate; and the fact that some wires are free from such deposits to the end of their lives, confirms me in the idea which I have formed on the subject.

To understand the whole matter, we must go back to the wireworker's establishment, and see what he has to do with it. After a wire has been seamed it is stretched upon two beams of wood, the seam being brought upon the rounded edge of one of the beams, where it is beaten flat with a wooden mallet. This beating process is absolutely necessary with a view to flatten the seam, which otherwise would cut the paper at the couch-roll. If this beating is not done by a thoroughly experienced person, it has a tendency to close up the seam, as well as small portions of the wire immediately before and behind the seam. In fact, the seam may be almost completely closed, and the immediate front and back only partially so. Now, as long as pulp is in a comparative state of agitation there will be very little deposit; but when the pulp is well forward on the wire, and has practically ceased to be in suspension, there may be a deposit upon the wire, which, on the arrival of the pulp at the vacuum boxes, will be drawn through the wire and pass on with the back-water. But when this matter is deposited upon the seam and immediately before and behind it, it is retained—the meshes of the wire being so closed up with the beating of the seam that there is no room for the particles to pass through, and, from their fibrous nature, they are retained, and they rapidly close up the minute meshes, consequently showing up on the paper.

Hence I am of opinion that the cause is defective beating of the seam, as two wires from the same maker, run on the same machine and making the same class of paper, will not show up alike—one filling-up at the seam, while the other remains clean until the end of its life,—which goes to prove to a certain extent that I am right. Of course the theory which I have put forward is not absolute, but is feasible, and ought to bring the opinions of practical men to the front.

Again, we have often in our experience seen wires breaking out at the seam. This cannot be attributed to the maker of the wire, unless he seams his wire with a defective metal, which I am sure no maker would do. I am informed that the fine wire which is used for seaming is of the very best quality and of extraordinary strength. If a wire goes at the seam, the cause is, as a rule, due to defective vacuum boxes. The seam being the most prominent part of the wire, it comes in more violent contact with the vacuum boxes than any other part of the wire; and if these boxes are in bad order (that is, waved on the surface), the effect is greater. To get a vacuum, the machineman finds it necessary to keep raising up the boxes in more close contact with the wire, which invariably results in wearing out the seam. Of course it is quite possible that the seam itself may be faulty, which can be seen upon examination at the end of the wire.

I once saw a Russian machineman completely cure a wire which I considered past all possibility of making paper. In starting the machine he had what we call a "lick up" at the coucher, and a lump of pulp passed through between the couchers, making a large slack place in the wire. He at once stopped the machine, and made walls of pulp from front to back on the wire. The slack part of the wire being about three inches wide, he made the walls of pulp six inches from each side of the damage. He now poured dilute sulphuric acid on the wire between these walls of pulp. After a time he washed out the acid, and then held a bar of hot iron inside the wire, moving it from front to back until the wire was thoroughly heated. He then tightened up the wire, and started off as if nothing had happened. It was the best and simplest cure I had ever seen for such an accident.

I have often remarked that wires generally come out in holes at the back of the machine first, which I can only account for by the fact that all accumulations of fine sand, clay, &c. which lie on the breast-apron and all over the breast of the machine, are, upon shutting down the machine, washed by the machineman to the back side, where they pass through the couchers, and often stick to the top coucher and frequently go round, thereby damaging the wire. It is surprising how small a particle of sand or metal will partially cut or fracture the surface of the meshes of the wire; and the continual bending of the wire as it passes round the various rolls soon causes it to break and come out in a hole.

I have used a very good contrivance for the prevention of such;—that is, I placed a doctor behind the doctor proper and down the back of the couch-roll to slightly under the centre. This doctor had slotted holes in the end, whereby it could be put in contact with or taken off from the couch-roll at pleasure. It was only used in starting and in stopping the machine. This doctor requires a strong stream of water running over it from front to back, to wash away anything deposited upon it by the couch-roll.

CONCLUSION.

My theories, arguments, and practical experience may not be in unison with the ideas and experience of many of my fellow-workmen, whose lines have been cast in different, and possibly more pleasant, places than mine have been. At all events, I must say that they are the outcome of my own experience and my own observation, both in my own country and amongst strangers. I could write much of what I have heard as to how business was carried on outside of where I have actually been employed, but such information would not be reliable, and it would possibly be considered as interfering with the affairs of other people, with whom I have nothing to do.

I have been as careful as possible to avoid giving offence to any one, either by referring to their private affairs or in exposing in any way that which is of a confidential nature; and, if anything I have written can be construed into giving offence, I am at least innocent of such intention, and hope that these Notes will be looked upon in such a light.

ADVERTISEMENTS.

BERTRAMS LIMITED

(Successors to GEO. & WM. BERTRAM, Established 1821)

ENGINEERS,

St. Katherine's Works, Sciennes,

EDINBURGH.

HIGHEST AWARDS FOR
IMPROVEMENTS IN PAPER-MAKING MACHINERY.

GOLD AND SILVER MEDALS.

LONDON 1862.

EDINBURGH 1886.

EDINBURGH 1890.

Makers of all classes of Machinery of the Newest and Most Improved Construction for the Manufacture of the various grades of Paper.

◆

Our Paper-making Machines

ARE AT WORK THROUGHOUT THE WORLD, AND ARE EQUAL TO A PRODUCTION OF ABOUT

300,000 Tons of Paper annually.

SPECIALITIES.

SUPERIOR

CHILLED ROLLS

For CALENDERS, PRESS and SMOOTHING ROLLS.

ABOUT 2000 ROLLS AT WORK.

PATENT DECKLE for WIRE FRAMES

(ARCHIBALD & PURDIE'S).

ABOUT 60 AT WORK.

STEAM ENGINES OF ALL CLASSES,

High-Pressure, Condensing, or Compound, up to any Indicated Horse Power.

ABOUT 500 AT WORK.

IMPROVED

PAPER-MAKING MACHINES.

ABOUT 140 AT WORK.

PATENT FLAT STRAINERS.

ABOUT 320 AT WORK.

SPECIAL STRAINER PLATES.

MANY THOUSANDS AT WORK.

ANGLE & SQUARE PAPER CUTTERS

ABOUT 250 AT WORK.

BERTRAMS LIMITED, Engineers,
St. Katherine's Works, Sciennes,
EDINBURGH.

W. G. TAYLOR & CO.,

83 Queen Victoria Street,

AND AT MANCHESTER. LONDON, E.C.

Sole Agents for the U. K. for the Celebrated

WANDEL

PATENT AUTOMATIC

Rotary Strainer

Simple in Construction,

Does thoroughly Clean Work,

Requires no attention, and

Very, Moderate in Price.

1100 are at present in use on the Continent, in England, and elsewhere, all giving the greatest satisfaction.

W. G. TAYLOR & CO.,

83 Queen Victoria Street,

LONDON, E.C.,

AND AT **MANCHESTER,**

SUPPLY AT LOWEST MARKET PRICES

ALL DESCRIPTIONS OF

Raw Materials for Paper-making.

◆

ESPARTO,

WOOD PULPS,

CHEMICALS,

COLOURS,

SIZINGS

LOADINGS.

* * *

Samples and Quotations on application.

General Machinery

Steam Engines,
Turbine Wheels,
Main Gearing,
Rope Driving,
Belt Driving,
Machine Moulded Wheels
With Plain or Helical Teeth;

ALSO

Complete Installations of Shafting, Pulleys, &c.

FOR

Electric Lighting,
Flour Mills,
India-Rubber Mills,
Linoleum Factories,
Breweries, Distilleries, &c., &c.

For the LINOLEUM TRADE.
Mixing Mills, Calenders,
Disintegrators, and other Machines.

BERTRAMS LIMITED

ENGINEERS,

St. Katherine's Works, Sciennes

EDINBURGH.

New Patents.

PAPER-MAKERS or OTHERS having brought out NEW INVENTIONS which present some decided advantage in PAPER-MILL WORK, will always find us ready to make an arrangement for pushing the Sale of such among our CLIENTS ALL OVER THE WORLD, under Royalty to the Patentee as usual.

Valuations:

IT IS A SPECIAL FEATURE OF OUR BUSINESS to VALUE PAPER-MILLS, including their

Water Rights, Buildings, and
all Appurtenances,

for the purpose of Selling or Purchasing Mills, Partnerships, &c.

These we have done largely both at Home and Abroad, and we are prepared **to Value and Report upon Mills in any part of the World.**

Bertrams Limited

ENGINEERS,

St. Katherine's Works, Sciennes,
EDINBURGH.

George Christie, Ltd.,

Manufacturers of

WOVE

SPIRAL

and

LAID

DANDY

ROLLS.

Watermarks and Monograms a Speciality.

First-Class Workmanship.—Moderate Prices.

Ladywell Wire Works, GLASGOW,

AND

130. Fleet Street, LONDON, E.C.

Telegraphic Address: "LADYWELL, GLASGOW."

ESTABLISHED 1865.

GEORGE CHRISTIE, LIMITED.

MANUFACTURERS OF

PAPER MACHINE WIRES.

MACHINE WIRES * * *
OF OUR
SPECIAL RUBY METAL.

Extra Strong Cable Warp Wires,

Tinned and Untinned—Specially Seamed.

Cylinder Covers. Washer Wire.

FINE CLOTHS to No. 200 Mesh.

Large Stock always on hand.

Fine Brass and Copper WEAVING WIRE, all Sizes.

Ladywell Wire Works,
GLASGOW, SCOTLAND.

Telegraphic Address: "LADYWELL, GLASGOW."

PAPER-MAKING MACHINES

FOR WOOD-PULPS AND OTHER FIBRES.

THESE we have made a speciality of, from the Strainers to the Reel, fitted with New System of Brackets for Couch and Press Rolls, Felt Drying Cylinders, Cone Gearing for the various parts of Machine, and also for altering the speed in place of Change Wheels.

Some of the Finest Machines in Scandinavia are of our construction, and we have received from the users the most satisfactory references as to their working.

PULP-DRYING MACHINES.

We make a speciality of Pulp-Drying Machines for Drying any quantity of Pulp, combined with Strainers, Improved Press Rolls, and Cutting Arrangements, for which we can give excellent references.

FRICTION & WEB-GLAZING CALENDERS.

These Calenders are constructed by us for any width and for any number of Rolls, combined with Friction arrangements, so that the Calender can friction-glaze or impart the finish to the Paper by rolling.

These Calenders are fitted with Hydraulic arrangement, for keeping the Rolls clear of each other when not at work, and they are also fitted with labour-saving appliances.

We also build Calenders specially for Friction-Glazing purposes, and combined Cooling and Damping Machines on the most improved principles.

EDGE-RUNNERS OR KOLLERGANGS.

Various sizes of Kollergangs, with flat or angle Surface Stones, are made by us.

VARIOUS FIBRES.

We are prepared to give the best advice on the conversion of any Fibre into Paper, and at all times to give the closest attention to new ideas coming from any source whatever.

BERTRAMS LIMITED, Engineers,

St. Katherine's Works, Sciennes,

EDINBURGH.

Latest Patents.

PEARSON AND BERTRAM'S

REFINING ENGINE.

Constructed on most modern and improved principles.
Takes less indicated horse-power than any other.
Occupies smaller space.
Bars wear longer, and can be replaced in twelve hours.
No heating of bearings which are outside of the Refiner.
Pulp produced is much cleaner than by ordinary Beater.
One-Third to One-Half fewer Beaters are employed.
Appearance and strength of Paper is improved.

D. N. BERTRAM'S

PATENT SIMPLEX FLAT STRAINERS.

Specially suited for Wood-Pulp Papers.
Ensures the whole Surface (6 ft. by 2 ft. 6 in.) to be efficient.
No Refuse Pulp remains on any part of the plates.
One Strainer is keeping a large Machine going producing over 40 Tons per week of Fine Printings.

D. N. BERTRAM'S

PATENT REELING MACHINE.

Vertical or Horizonal Systems.

This Machine Reels and Slits various classes of Paper, from thin Bag Paper to heavy White and Brown Paper.
The Deckle Edges are cut off the web before being wound up, and as the web is being wound up it is cut into widths.
This Machine has an Automatic arrangement for applying the Slitting Knives with any desired amount of contact, which will be retained until the whole web is finished.

All particulars of above Machine to be had from the Sole Makers of these Machines

BERTRAMS LIMITED, Engineers,
St. Katherine's Works, Sciennes,
EDINBURGH.

W. G. TAYLOR & CO.,

83 Queen Victoria Street,

AND AT MANCHESTER. LONDON, E.C.

Agents for all kinds of

Wood Pulps.

SODA,

SULPHATE,

SULPHITE,

DRY PINE,

MOIST-PINE.

Shipment to any Port in the U.K.

* * * * * * *

SAMPLES AND QUOTATIONS ON APPLICATION.

THE BEST BELTS FOR PAPER AND PULP MILLS

ARE THE

"Lancashire" Belts.

ADVANTAGES:

1. **They work in water, steam, heat, or acid vapours.**
2. **They are unequalled in grip, strength, and durability.**
3. **They run absolutely true and steady.**
4. **They stretch less than any other Belt.**
5. **They do more work than double leather, though costing less than single strapping.**

* * *

An old User says:

"I have used these Belts for the last twenty-five years, and find them to be the correct Belts for Paper Mills, as they **work wet or dry.** They last five to eight years on our Rag Engines, and give us no trouble. We formerly used Rubber Ply Belting, but found the "Lancashire" Belt, at about half the cost, a much better lasting Belt. We know there are many imitations of your excellent Belting, but we are well satisfied, and will use no other than yours, as it does its duty so well, both on Rag Engines and Paper Machines, &c."

Beware of Imitations. The SOLE MAKERS are the

Lancashire Patent Belting & Hose Co.,

New Bridge Street, MANCHESTER.

New Illustrated Catalogue on application.

PUBLICATIONS

Supplied to Clients, Free of Cost, by

BERTRAMS LIMITED

Engineers,

St. Katherine's Works, Sciennes, EDINBURGH.

Paper-Mill Machinery Catalogue,
With Large Illustrations from Photographs and Drawings.

Steam Engine Catalogue,
Including Steam Boilers and Mill Gearing, with Illustrations from Photographs and Drawings.

Paper Testing,
In the German Government Laboratory at Charlottenburg, including reduced Illustrations of Paper-Mill Machinery.

Photographs of the Scottish Capital,
With Descriptions of the City, Ancient and Modern.

Souvenir of Paper-Mills,
With Illustrations of many of the most important Home and Foreign Mills.

Specimen Book,
Containing Samples of various classes of Ordinary and Special Papers.

The "Practical Engineer's" Pocket Book and Diary,
With useful Tables and Memoranda for Engineers of all kinds of Mills.

Wheel and Pulley Catalogue,
With Weights of Castings in all sizes, and full Engineering Tables for reference.

Directory of Paper-Makers of Great Britain and Ireland.
POCKET EDITION.

Any Client not supplied with one of the foregoing Books will receive one on making application by post.

REPAIRS AND ALTERATIONS.

WE give the closest possible attention to urgent Repairs and special Alterations, so as to reduce the time of stoppages at Mills and make the most of existing Machinery and other Fittings.

A LARGE STAFF OF EXPERIENCED WORKMEN AND DRAUGHTSMEN is available for attention to the foregoing classes of work, and in all cases personal supervision is given, so as to meet the views and requirements of our clients.

Customers' Machinery Insured against Fire whilst in our Premises.

RE-SURFACING OLD ROLLS.

Chilled Calender Rolls,
Chilled Smoothing Rolls,
Hard Grained Rolls,
Brass Rolls,
Indiarubber Rolls,
Cotton Rolls,
Paper Rolls, &c.

OUR PLANT for re-surfacing the foregoing classes of Rolls is of the MOST EXTENSIVE and ACCURATE DESCRIPTION.

It is constantly in full employment, and most of the year is working overtime, very frequently double shift, which is perhaps THE BEST EVIDENCE WE CAN GIVE of the success of our work in this direction.

BERTRAMS LIMITED, Engineers,

ST. KATHERINE'S WORKS, SCIENNES,
EDINBURGH.

FELTS FOR PAPER-MAKERS.

James Kenyon & Son

FELT-MAKERS,

Bury, Lancashire.

MAKERS OF ALL KINDS OF

FELTS

For PAPER-MAKERS.

Patent Cotton Dry Felt

with Improved, Seam.

Speciality

WET AND PRESS FELTS

for Fast-running Machines making News from Wood Pulp.

COUCH-ROLL COVERS, &c.

Telegrams - - - "KENYON, BURY."

Awarded Seven Gold Medals at International Exhibitions
for Excellence of Manufacture.

THORNTON & CO.,

Patentees, Waterproofers,

—AND—

India-Rubber Manufacturers,

EDINBURGH, GLASGOW,
BRADFORD, LEEDS, LONDON, & BELFAST.

INDIA-RUBBER BELTING,

Superior quality of the most approved construction.

DECKLE STRAPS,

A product of reliable manufacture.

STRAINER BELLOWS,

For Revolving and Flat Strainers.

VALVES,

For Marine and Land Engines.

*Delivery Hose, Suction Hose, Steam Hose, Sheet Rubber,
Packing, Washers, &c.*

THORNTON & CO.

India-Rubber Manufacturers,

Head Offices and Export Warehouse: 2 Hanover Street, EDINBURGH.

Price-Lists and References on application.

STRAINER PLATES.

Our PLATES are made of a SPECIAL MIXTURE, which will withstand the effects of Chemicals, and RECLOSE OFTENER than any other, as has been testified by many Paper-makers using them.

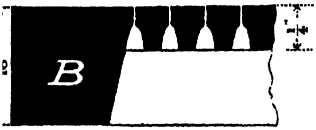
			Prices.
Class B .	$\frac{1}{4}$ in. thick on body,	edges $\frac{11}{16}$ in. deep,	3d. sq. in.
,, B2 .	$\frac{5}{16}$,, ,,	,, $\frac{11}{16}$,, ,,	3½d. ,,
,, C .	$\frac{3}{8}$,, ,,	,, $\frac{7}{8}$ or 1 ,, ,,	4d. ,,
,, C2 .	$\frac{7}{16}$,, ,,	,, $\frac{7}{8}$ or 1 ,, ,,	4½d. ,,
,, D .	$\frac{1}{2}$,, ,,	,, 1 ,, ,,	5d. ,,

Subject to Discount, which may be ascertained on application, according to Class, Size, and Quantity required.

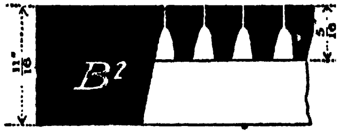
We have many other Patterns of Plates to suit Special Strainers.

Sample Pieces of Plates supplied, showing the various Numbers of Cuts.

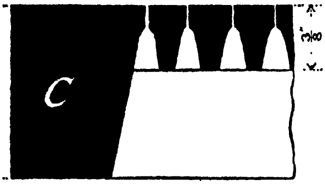
USUAL SECTIONS OF STRAINER PLATES. *Full Size.*



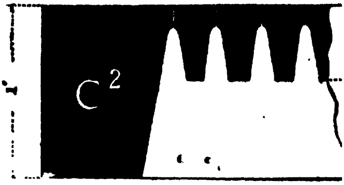
Class B, Ordinary Section.



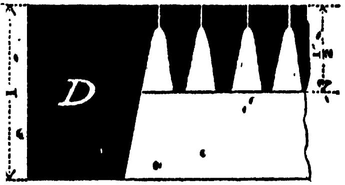
Class B2, Ordinary Section.



ss C, 1″ Margin for Patent Flat Strainers.
ss C, $\frac{7}{8}$″ Margin for Jog Strainers.



Class C2, Ordinary Section.



Class D, Ordinary Section.

BERTRAMS LIMITED, Engineers,
St. Katherine's Works, Sciennes, EDINBURGH.

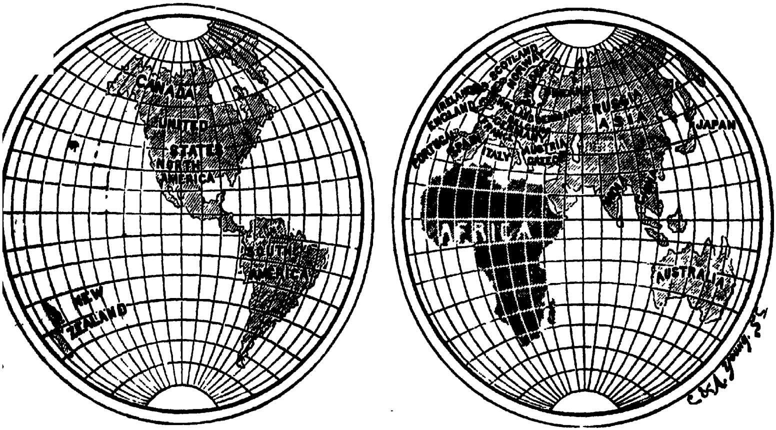
BERTRAMS LIMITED

ENGINEERS,

St. Katherine's Works, Sciennes.

EDINBURGH.

MAKERS OF ALL CLASSES OF MACHINERY
OF THE NEWEST AND MOST IMPROVED CONSTRUCTION
FOR THE MANUFACTURE OF THE VARIOUS
GRADES OF PAPER.



During the past few years we have supplied an exceptionally large number of New Paper-making Machines, with all Modern Improvements, for Mills at Home and Abroad, to which we shall be pleased to give special references to intending purchasers.

◆

TO BUYERS OF PAPER-MAKING MACHINERY.

We can give a List of Millowners to whom we have supplied our Machines during the past 70 years in different Countries, per above Map.

We produced 12 Large Paper-making Machines in one Year—1890.

This fact speaks for itself.

INSPECTION OF OUR WORKS by Customers invited at all times, giving us a few days notice, that Principals may be at home.

CHR CHRISTOPHERSEN,

CHRISTIANIA,

Manufacturer and Exporter

OF ALL KINDS OF

Chemical and Mechanical

WOOD PULPS

* * **Branch Offices:** * *

CHR. CHRISTOPHERSEN'S FILIAL,
GOTHENBURG.

CHR. CHRISTOPHERSEN & CO.,
39 Lombard Street,
LONDON, E.C.

Agents for Scotland * * *
Messrs ANDREWS & CO.,
9 South St Andrew Street,
EDINBURGH

WOOD PULPS.

W. Grant & Co.,

17 BALTIC STREET,
LEITH

Agents for the Best Makers.

SULPHITE,
SULPHATE,

PINE,
ASPEN.

Third Edition, Revised and Enlarged,
OF

THE PRACTICAL PAPERMAKER:

A Complete Guide
TO THE
MANUFACTURE OF PAPER.

By JAMES DUNBAR.

LEITH: MACKENZIE & STORRIE, 35 SHORE.

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

MEMORANDA

دق

سلم

[illegible]